Devoted to Civil Engineering and Contracting

March 10, 1921

Engineering News-Record

Platforms, Signals and Track Entrance at New Waterloo Station of London & Southwestern Railway
Largest Passenger Station in England

A Group of Articles of Interest to Railway Engineers

Review of Column Formulas for Bridge Design
By An Engineer of Bridges

Reconstruction of Upper Deck on Eads Bridge Approach
By E. C. Albrecht

The Bagdad Railway—An International Problem

Long Concrete Piles Built Up With Cement-Gun

Enlarged Waterloo Station, London & Southwestern Railway

A Study of Subsidence Under Railway Fills

Plant and Equipment for Lining the Selkirk Tunnel

McGraw-Hill Company, Inc.

Federal Cement Tile Withstands The Acid Test

Detroit Pressed Steel Co.

MANUFACTURERS OF
AUTOMOBILE FRAMES
STEEL STAMPINGS

PHONE RIDGE 4100

3800 MT ELLIOTT AVENUE
Detroit

May 15th, 1919.

Federal Cement Tile Company,

Chicago, Illinois.

Gentlemen:

We have, this day, tested two of your Standard Red Pitched tiles which were taken from our Pickling Building, which has been in continuous service. One tile bore the date of May 5th, 1915, and was coated on the underside with asphalt paint. The other was dated August 10th, 1917, which was an addition to the Pickling Building and was not painted on the underside.

The first tile broke under a uniformly distributed load of 3800 pounds and the second one at 3900 pounds. We found the reinforced metal clean and bright in every respect after the tiles were broken into many pieces.

The concrete was sled in good condition and we were pleased to learn that the carrying capacity of the slab had increased about seventy percent over tiles 30 days old.

Trusting this will be of service to you, we remain

Yours very truly,
DETROIT PRESSED STEEL CO.
John M. Bischoff
Construction Engineer

JMB-FF

Another Example of Federal Roof Permanence

Acid fumes in the Pickling Room of the Detroit Pressed Steel Company have eaten their way into the underlying steel work, but the Federal Cement Tile in the roof are stronger than the day they were installed, as stated in the accompanying letter. This is merely an added proof of Federal Indestructibility under unusually severe conditions.

Make your new roof *proof against fire, weather acid fumes and age.*

"The Indestructible Roof"

FOR FLAT and PITCHED SURFACES
Made, Laid and Guaranteed by

110 S. DEARBORN ST.
CHICAGO

HAMMOND, INDIANA — Works — DETROIT, MICHIGAN

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

Volume 86 — NEW YORK, THURSDAY, MARCH 10, 1921 — Number 10

Railway Engineering Convention

THIS number is largely devoted to the problems of the railroad engineer, for it appears just before the annual convention of the American Railway Engineering Association. That body will assemble in Chicago next week for the second time since the railways have been returned to private operation. The problems that loomed big a year ago are still big today. If anything, the railroads are even more in the public eye. They have an unusual measure of public support at the present time but they will have to fight hard to deserve it. There is insidious adverse propaganda, on top of the tremendous obstacles caused by inadequate revenue. The greater the difficulty and stress, however, the greater the demands upon those engaged in railroad service. More and more, engineering analysis and engineering methods must be applied to secure a satisfactory solution for the present bad situation. If the matter of terminal operation alone be mentioned there is sufficient warrant for the preceding remark to make extended explanation unnecessary.

An Engineer for the I. C. C.

FOUR vacancies exist at the present time in the Interstate Commerce Commission which would seem to make an excellent opportunity to promote the appointment of at least one engineer to the commission. The arguments in favor of having an engineer on a commission of this sort have been so often detailed that they will not be repeated here. In the case of the Interstate Commerce Commission, however, the recent broadening of its powers by the Transportation Act requires, more than ever, thorough familiarity with the mechanism of the railroad machine. An engineer, assuming of course that he have the proper qualifications, could render an invaluable service to the nation in the capacity of Interstate Commerce Commissioner. The purpose here, however, is not to argue the case but to urge upon engineers individually and upon engineering societies that they communicate to the new President their desire to see an engineer appointed to the commission. To do that is merely to follow the accepted procedure in trying to get before the chief executive the views of a large number of citizens.

Shrinkage and Subsidence

RAILWAY embankment quantities have generally exceeded the estimates and during subsequent years of operation additional material has been required to maintain the normal height and width of fills. These conditions are due to causes which have been grouped chiefly under two heads, first, shrinkage of the fill material and, second, subsidence of original ground under the weight of the fill and the weight and impact of traffic. The excess quantities represent expenditure for material and labor, but, as a rule, the records of such quantities and costs are very meager, owing in part to the fact that most of the work has been done in innumerable small jobs. When valuation of the railways was undertaken this excess material became of great importance to the railways in order that they might receive credit for great aggregate expenditures thus incurred for excessive earthwork. Extensive studies have been undertaken and information has been repeatedly published in *Engineering News-Record* giving the data disclosed. In this issue will be found the results of an extensive investigation of subsidence made by the carriers. These explorations have not only discovered enormous quantities of lost earthwork but have also shown that subsidence beneath embankments is almost universal. It is also shown that shrinkage and subsidence must be treated as separate in an engineering investigation. The results should be of as great value to engineers engaged in construction and maintenance as to valuation engineers.

The Price Situation

WHEN the price situation, as affecting construction costs, is discussed it is always apparent that many people can not divorce themselves from the belief that there can be no normal price level but that of 1913. True, practically everybody would like to get back to that level. We feel that at present levels the economic situation is "out of joint." But thinking will not bring it back to where it was in 1913. We know that after the Civil War it took twenty years to restore the old levels. No one can predict with certainty that that history will be repeated, but not merely historical precedent but present indications as well point to a slow deflation from now on. In many lines we have had large decreases and some people predict that the recent inclination of the downward curve will continue. Most authority, though, inclines to the belief that the slope will change to a flatter one. If that expectation be correct, it will be several years before large reductions can be realized in construction costs. In other words, if structures are urgently needed those who postpone them in the hope of being able to make large savings this fall or next spring are likely to be disappointed. Above all there seems no doubting the wisdom of going ahead quickly with any work that must be done this season.

Effect of Foreign Trade

WITH our inexperience, relatively at least, in export matters we do not as a people appreciate the bearing of export trade upon domestic prosperity. That is true despite the jolt which every individual received when the outbreak of the European war disarranged our export trade and brought with it a temporary unsettlement of our whole commercial structure. The farmers, whether they raise wheat or cotton, appreciate what Europe's failure to buy means to their individual

prosperity and they backed to a man the re-establishment of the War Finance Corporation. Most city people, however, remain indifferent to the export situation. Engineers and contractors, no less than every other class, are directly concerned, for the present depression in construction is due, in part at least, to the lack of purchasing by the farming communities, and that in turn is traceable to the slackness of export demand. The export of manufactured goods as well would keep our people busy and re-establish their purchasing power. For these reasons engineers and contractors should have a keep interest in the functioning of the War Finance Corporation and in the organization of the Foreign Trade Finance Corporation, the $100,000,000 private enterprise whose formation, with the backing of bankers all over the country, is now practically accomplished. Both have the function of making long term loans for the financing of exports and should be material factors in retaining—or re-gaining—much of the trade we developed during the war and of again supplying the European customers who temporarily, on account of the adverse rates of exchange, find it impossible to buy in this market.

Column Formulas Again

WHAT is said on column formulas on p. 431 of this issue reflects the personal convictions of a single engineer, but is likely to receive the approval of many, for the time-honored Rankine formula still has strong advocates. Their faith in it rests on the fact that tests over a sufficiently wide range usually indicate a dependence of carrying capacity on length according to some law represented by a line of reversed curvature. Granting this fact, the Rankine formula may very fairly be taken as the simplest expression of such a curve. Up to this point of the reasoning the question of column strength is one of fact rather than of interpretation or opinion; but beyond this point the matter becomes less simple. Testing-machine service and field service have to be correlated before test curves can be translated into formulas for working loads. The crucial question of this part of the problem, namely, whether the "exposure" of a column in actual service is directly parallel to its exposure to the attack of load in a testing machine, has had little discussion. Limitation of column length in structures depends on the same question.

Testing for Toughness

EVERY distinct experience in the service of steel structures furnishes a new reason for ranking toughness or ductility as the paramount quality of structural steel. There is a very general feeling among engineers, too, that steel is desirable or undesirable according to its toughness, more or less regardless of ordinary test-report figures or chemical analysis. Many engineers—chiefly the "old-fashioned" ones—would be willing to accept or reject steel on the basis of toughness alone. They do not do so, however, and cannot, because there is no accepted test for toughness. In fact, the quality itself is not clearly defined, and probably it is not even a single quality but a group of qualities, each depending on the particular kind of physical action involved. Cracking around a rivet-hole as the effect of punching, for instance, may depend on different qualities from those involved in making a bend. There is room for research in this field; it might ultimately develop a satisfactory test for toughness, and greatly simplify the whole matter of steel quality in the structural field. With the aid of satisfactory test methods and the knowledge derived from research, it will be possible to investigate important questions of the relation between structural strength and workmanship. In a recent accident, where the steel gave good account of itself, reamed rivet holes were involved, we are informed, and it is suggested that the reaming increased the toughness of the fabricated material. There is little or no knowledge in print on which to base a conclusion concerning this point, and until we are nearer agreement as to what toughness is and how it should be measured, the matter must rest largely on individual opinion.

Indictment of Cement Companies

LAST week a federal grand jury at New York returned indictments against seventy-four cement companies and some of their officers for violating the Sherman anti-trust law. It is alleged that the indicted companies and officials engaged in a conspiracy to fix prices, to divide territory, to withhold cement from the market and prevent it becoming a commodity of free and unrestricted sale, and to curtail the production of cement. The indictment is the outcome of the New York legislative inquiry into the building industry. In view of the prevalence among contractors and engineers of the belief that cement prices are fixed by arrangement among the companies and that the distribution is similarly controlled, it is desirable that the case come to early trial, to the end that the practices may be stopped, if unlawfully existing, or that the cement companies be exonerated. In August, 1919, action was begun against nineteen eastern cement companies, on substantially the same charges, in the U. S. District Court at Trenton, N. J. The defendants filed their answer but nothing has been done since. It was the government's "move" and the government has not acted, despite a "grand-stand play" by the attorney-general at the time to the effect that the suit was the first action of the government in an effort to reduce the "cost of living." The New York legislative hearings were unfair and carried no conviction to fair minded men—as was pointed out in this journal, Jan. 27, 1921, page 155. The effect of these actions, nevertheless—without proving anything—is to increase in the popular mind the already existing belief that there is collusion. Unfortunately, the legal mill grinds slowly. We shall probably have to wait long for a decision, which is bad both for the cement companies and their customers.

Should Engineering Corporations Be Licensed?

THERE is agitation in New York State to have repealed that section of the engineers' licensing law which permits the licensing of engineering corporations and partnerships. The protest against the offending section is sound, and should have general support. Engineering service, of its very nature, is of a personal character. It involves judgment which necessarily cannot inhere in an impersonal body, no matter how much previous experience may be found embodied in reports on its shelves. Each engineering problem is distinct and different. There may be elements that are so simple and so well standardized that they require a minimum of engineering experience to apply, but their combination into a

solution or the mere decision to apply them demands a training and balance that can only inhere in the individual. Moreover, the value of that judgment flows directly from the individual and can in no way be enhanced by corporate name or financial standing. The quality of the engineering service rendered by a corporation can not rise above the quality of its engineers. These engineers then, as individuals, should be made to stand out before the public and to carry openly the responsibility which, in fact, is theirs.

The principle of personal service in the professions is clearly recognized in law and in medicine. Neither law firm nor corporation of physicians as such may be admitted to the bar or practice medicine. The work of the engineer is no less of a personal character than theirs.

This action of the New York engineers, to secure repeal of the section, will do much to win over to licensing those who have had doubts as to its value. If licensing can in so conspicuous a way help to fix the professional status of the engineer, it will have a distinct achievement to which to point.

Now that the question has been raised, it would be well to pursue it in those other states that have in their licensing laws the anomalous provision of admitting corporations and partnerships to the practice of engineering.

A European-Asiatic Railway Problem

IN THE Bagdad Railway, described elsewhere, may be seen a striking example of the interlocking and conflicting interests of European countries in developing their foreign commerce and in supporting their colonial possessions. Its history illustrates also the effects of European international quarrels on the progress of an ambitious engineering undertaking.

Great Britain has long wanted a line from the Mediterranean to the Persian Gulf as part of an "overland route" to its Indian empire, to shorten or avoid the present long sea voyage. Germany has wanted a line from the Bosphorus through Asia Minor as a means of extending its political and commercial interests and becoming a rival of Great Britain in "the East." France also has had such a line under consideration. Russia has been afraid of the project as likely to interfere with its own plans of commercial and political expansion. Turkey, in whose territory the route lay, had no local interest in the railway for its own development, but was willing to use the scheme as a tool or weapon in dealing with the European powers.

After years of diplomatic negotiation and intrigue, Germany received a concession for the railway. Russia promptly exerted political pressure to secure a radical change in one end of the route and Great Britain exerted similar pressure to block the other end. But construction advanced steadily. Since the war, one part of the line has come under the control of France, the other under that of Great Britain. What arrangements will come out of these new complications of war and national rivalries can hardly be predicted.

The characteristic of the international features is that the railway is a strategic tool of a foreign power and not a means, except incidentally, of developing the country through which it passes. Any foreign investment necessarily may involve international complications, but the difficulties are immeasurably increased when the investment is purely a military tool.

Machines in Snow Removal Work

IN CLEARING New York City's streets of the 12½-in. depth of snow deposited by the storm of Feb. 19-20, the Department of Street Cleaning demonstrated the effectiveness of mechanical equipment, an innovation this year. It is true that conditions of temperature, snow density and labor supply—all important factors—were more favorable this year than last, when traffic was paralyzed for several weeks. Nevertheless, credit for keeping the streets open is chargeable, not so much to luck as to advance planning and the use of machinery in place of the slow hand methods of former years.

The outstanding feature of this year's method of attack, as described on p. 415, was the use of tractors, wide-blade plows and motor trucks. Snow-plowing, with 10-ft. blades, was done in three ways—with pull-plows hauled by 2-ton tractors of the "tank" type and with push-plows mounted on the front ends of the heavier 4-ton caterpillar tractors and the 5-ton motor trucks. This work was successful in clearing traffic lanes by pushing the snow toward the gutters or, in the case of a broad thoroughfare like 5th Ave., toward the center of the street. The piled snow was then disposed of by the department's new fleet of more than 300 motor trucks, in addition to the vehicles of the snow-removal contractors.

A few attempts at mechanical loading were made, but the bulk of the loading was by hand-shoveling. In this feature the department has a field for study and experiment. The inclined elevating conveyor has possibilities of usefulness in cases where piled snow has not frozen into a solid mass. Its effectiveness depends in large measure on the skillfulness with which the operator of the motor truck being loaded backs his machine underneath the discharge end of the conveyor and follows its advance. With the movement of the two machines—truck and loader—not synchronized, much of the snow is spilled outside the truck body.

We believe, as stated editorially in our issue of Feb. 19, 1920, p. 355, that the small revolving-type of steam shovel would be an effective tool for loading piled snow. Its action is positive and it would stand up to its work under conditions of frozen masses where the elevating conveyor would have difficulty in functioning In the metropolitan district during the winter there are many idle shovels which the street cleaning department could rent with profit to itself and to the contractors.

One more feature of this year's program is worth noting: The best tractors and trucks must be maintained properly and facilities provided for minor repairs. The city was not organized with an adequate mechanical staff to keep its machines tuned up, and if another storm had followed the first, many of the tractors and trucks might have been laid up, due merely to lack of proper mechanical supervision. For mechanically operated vehicles, like the highways over which they operate, adequate maintenance must be provided. Especially was this need urgent in New York's case where the bulk of the truck and tractor drivers were comparatively "green" operators.

All in all, however, the handling of this season's snow work marks a distinct advance. Many improvements will probably be developed as a result of the lessons of this year's storm, but the encouraging feature is the clear conception of the work as an engineering job and the employment of mechanical tools in place of the slow hand methods of the past.

Reconstruction of Upper Deck on Eads Bridge Approach

Corroded Steel and Timber Roadway Floor Replaced with Concrete Without Interrupting Railway or Highway Traffic

By E. C. Albrecht
Assistant Engineer, Terminal Railroad Association of St. Louis

Corrosion of steel framing of the upper roadway deck of the western approach to the Eads Bridge over the Mississippi River at St. Louis, Mo., has necessitated the reconstruction of part of the roadway. The work had to be done without interrupting traffic either on the roadway or on the railway tracks below; both the design and the methods of execution were largely determined by this requirement.

The corrosion was caused by smoke and gases from locomotives on the railway tracks of the lower deck.

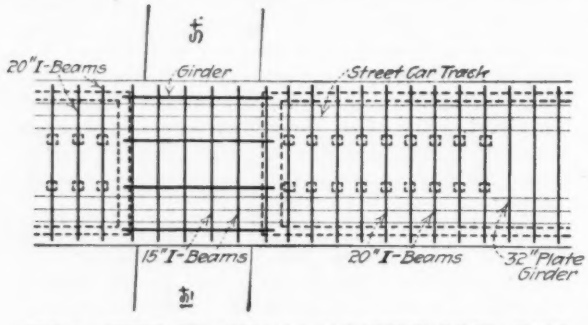


FIG. 1. STEEL FRAMING OF OLD UPPER DECK: EADS BRIDGE APPROACH

Reinforced concrete has been used in the new work in order to eliminate all exposed steel, the concrete being protected against the blast of the engines by cast-iron plates. This work, which will be completed in 1921, extends the full length of the approach, 693 ft. The bridge is operated by the Terminal Railroad Association of St. Louis and the work is being done by company force.

Typical construction of the old deck, as built during 1900-1903, is shown in Figs. 1 and 2. Two solid 30-in. walls of stone masonry extend down to bed rock and between them is an earth fill to the level of the railway tracks on the lower deck of the bridge. The upper deck, for highway traffic, was carried by transverse 20-in. 65-lb. I-beams spaced from 7 ft. 7 in. to 9 ft. 1½ in. c. to c., these being supported on the side walls and on timber posts resting on brick piers carried down to rock. On the I-beams were timber stringers, dapped in such a way as to give a 4-in. crown to the roadway. A deck of 3½-in. yellow pine planking was spiked to the stringers and made watertight with a layer of 2-ply tarred roofing paper, upon which was the 3½-in. creosoted wood block paving.

Near the east end of the approach, plate girders were used, spanning the entire width between side walls. These girders, spaced 8 ft. 3 in. c. to c., consisted each of a web plate $\frac{7}{16}$ x 28½ in., four flange angles 5 x 3½ x ½ in., and two 10½-in. cover plates ⅜- and ½-in. thick. In this part of the structure the railway tracks are laid on an earth fill upon brick arches which are 30 in. thick at the crown and rest on stone piers 7½ ft. thick extending to bed rock. Across two streets and an alley, the upper deck was carried by four longitudinal girders, those on the outside resting on the side walls of the bridge and those on the inside being supported by steel columns. Across these girders were 15-in. 80-lb. I-beams to carry the timber deck. The lower or railway deck is carried over each of these streets by four plate girders resting directly on the walls at the street lines.

All the brick and stone masonry in the walls, piers and arches is part of the original Eads Bridge, built in 1872. Careful inspection in 1917 showed that this work was in very good condition. Only well burned bricks (exceptionally hard in those days) were used, and the stone was mostly limestone from quarries at Grafton, Ill. All brick and stonework was laid in cement mortar, but the available records do not indicate the quality of the cement used.

Condition of Approach

The upper deck, described above, was built in the period 1900 to 1903, but by 1917 the condition of this steelwork was such that its renewal would have been necessary had it not been decided to rebuild the entire deck in concrete. Although the corrosion was general on all of the exposed steel it was particularly severe on the flanges and webs of the beams directly over the railway tracks, due to the severe blast from the locomotives. That this blast is of unusual intensity is evident from the comparatively short life of the structure, 17 to 20 years and can be attributed directly to two causes: (1) the engines are working hard on the heavy grade, and (2) the clearance from top of rail to underside of girders is as low as 16 ft. in some places, so that the smoke and cinders are blown forcibly against the steel.

Another cause which, in the writer's opinion, contributed largely to the rapid deterioration of this steelwork was the large amount of dirt and soot which clung to the webs and flanges of these beams, and which in combination with moisture led to a chemical reaction that quickly attacked the steel. The moisture was due mainly to steam condensing on the steel. No doubt a certain amount of water leaked through the deck, but this was a very small factor. Under the circumstances it was impossible to keep this steel clean and well-painted. Reconstruction was contemplated shortly before the war, but had to be abandoned at that time.

Reinforced concrete throughout was adopted for the new deck, as shown in the drawings. Fig. 3 is a typical section. The lower level is divided lengthwise into two corridors by a 36-in. wall of concrete, having openings at varying intervals to provide access from one side of the bridge to the other. The 10¾-in. upper roadway slab is reinforced with ¾-in. square rods spaced 6 in. c. to c. and the 5½-in. sidewalk slab with ⅝-in. square rods 5½ in. c. to c. Floor beams supporting the slab have a clear span of 20½ ft. and are cantilevered 33 in. beyond the face of the masonry bridge walls to receive the sidewalks. These beams are 28 in. thick and 33 in. deep below the slab, their spacing (as for the old steel beams) varying from 7 ft. 7 in. to 9 ft. 1½ in. c. to c. Each beam is reinforced with eight 1-in. square rods, and four-prong ½-in. square stirrups spaced 12 in. c. to c. throughout. To protect the concrete from the engine

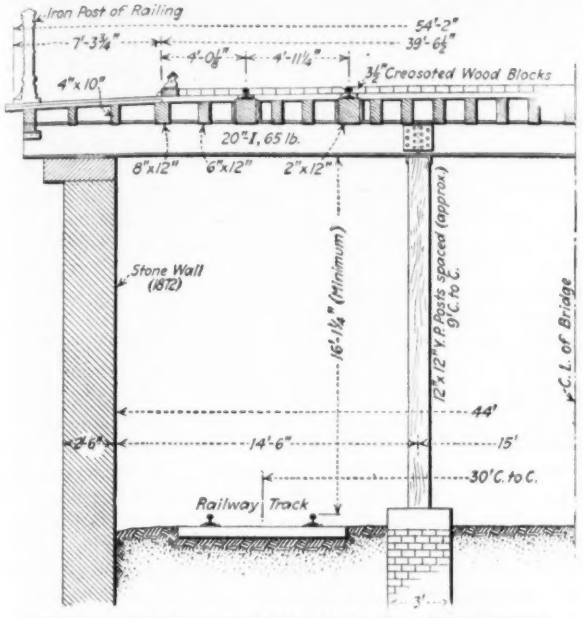


FIG. 2. TYPICAL SECTION OF OLD UPPER DECK CONSTRUCTION

blast a 1-in. cast iron blast plate 28 x 36-in. is provided in the bottom of each beam, lugs on the castings being embedded in the concrete.

Street car tracks are located at the sides of the roadway, the center being open to vehicular traffic, so that the crown had to be formed in two separate parabolic curves. With the customary type of crown there would have been a difference in elevation of 2 in. for the two rails in each track, which could not be permitted. It was decided, therefore, to place both rails at the same elevation, with a flat space between them. From the curb to the nearest rail, the roadway is given a rise of 3½ in., and from the other rail to the center the roadway rises 2½ in., making a total of 6 in. from curb to center line of roadway. Each rise was worked out as a separate parabola, and the resulting crown is found to be satisfactory. A concrete fill on the slab is shaped to the desired crown. The roadway is paved with 3½-in. creosoted wood blocks, laid in a heavy coat of hot pitch spread over the concrete, no sand cushion being employed. The sidewalks are finished with ½-in. of 1:1 cement mortar. An ornamental concrete fence is provided on each side.

At street crossings the deck is supported on three heavy reinforced concrete girders as shown in Fig. 5. The two side girders have a clear span of 46 ft. and are 30 x 100 in. in section. The reinforcement consists of 1¼-in. square rods and ½-in. two-prong stirrups, aranged in pairs and spaced at varying distances. The center girder has a clear span of 43½ ft. and is 36 x 107 in. in section, with similar reinforcement. Cast-iron scuppers are placed at the streets to drain off the storm water. Expansion joints in both the roadway slab and the center wall are provided at intervals of approximately 50 ft.

Construction Methods

As it was necessary to keep both the upper and lower deck open to traffic during the reconstruction, it was decided not to remove any of the old decking until the 36-in. longitudinal central wall was completed. Work was started in June, 1919, the wall being poured in lifts about 4 ft. high and in sections about 50 ft. long. A mixer was placed between the tracks and a short distance ahead of the section under construction. All concrete was placed by hand, the laborers pushing wheelbarrows

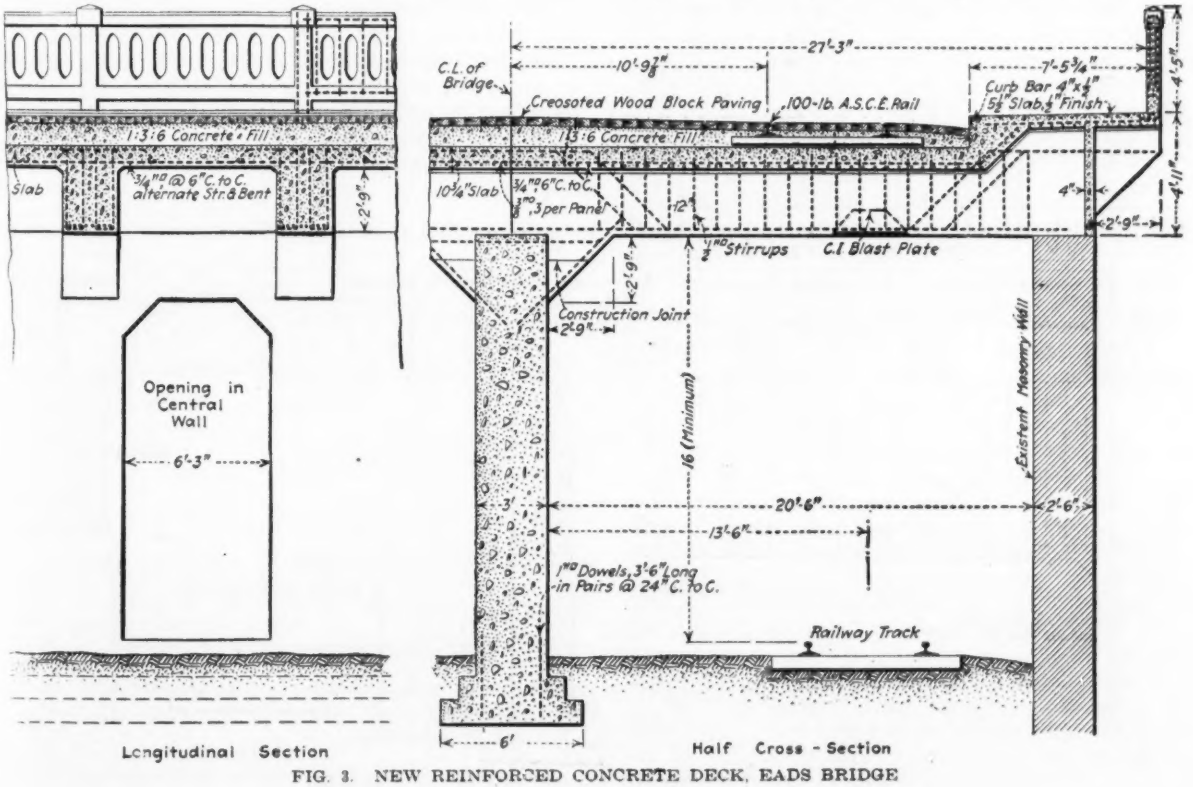


FIG. 3. NEW REINFORCED CONCRETE DECK, EADS BRIDGE

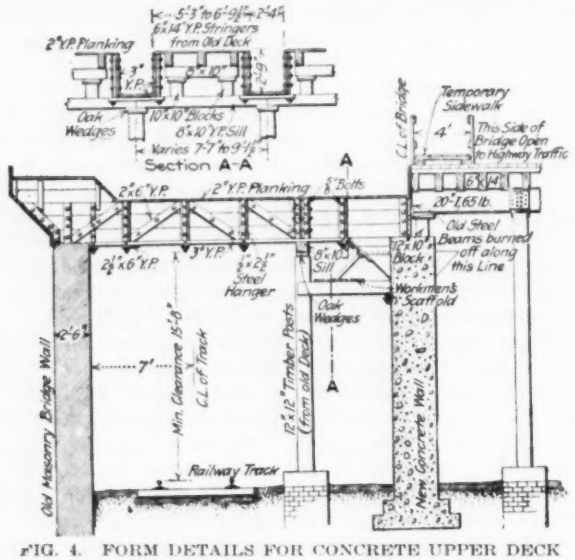


FIG. 4. FORM DETAILS FOR CONCRETE UPPER DECK

up an incline to the full height of the forms. The heavy center girders across the streets and alley were also poured in conjunction with the wall. Each girder was poured in one continuous operation, requiring 22 hours. There was no interference with railway traffic, the cars for handling material being operated between trains. The wall and center girders were completed Oct. 20, 1919, and work was then suspended until the next spring.

Operations were resumed May 16, 1920, the north half of the upper deck being started. A derrick mounted on a flat car on this deck is used to tear up the old flooring and moves east as the work progresses. Highway traffic is confined to the south half of the bridge opposite the section torn out. At the west end of the work was placed a 54-ft. concreting tower with chutes suspended from cables and capable of reaching to a distance of 175 ft. This plant was mounted on trucks and moved east as each section was completed. Fig. 6 shows the derrick and concreting plant.

In the first place, a section of the old decking, two panels or about 18 ft. in length, is torn out, the material being dropped into cars on the railway track below. Everything is removed except the steel I-beams. Heavy wooden blocks are placed under these beams on the center wall and wedges driven so as to take a firm bearing. The beams are then burned off with an acetylene torch, and lowered into the cars. The timber posts are then cut off to the proper elevation and beams 8 x 10 in. are placed upon them to support the forms. The beam forms are hoisted from cars on the railway deck and placed over the posts by the derrick. These forms are delivered complete and each is handled as a single unit. The derrick then moves on for another length of 18 ft. and the above operations are repeated.

The beam forms, Fig. 4, are of an unusually heavy type, because of the great weight to be carried and their long span of 14½ ft., this span being necessary because the railway track had to be kept open to traffic. After the forms are completed and the reinforcing steel is placed for a length of approximately 175 ft., the wrecking of the old deck is stopped and concreting is begun. The beams and roadway floor slab are poured first, with all construction joints made at the center of the floor spans. The street car track is then laid, and the fill concrete and sidewalk slab are poured as the second operation.

During the construction of the north half of the deck, all traffic passes over the south half, directly opposite the section torn out, a watchman being stationed at each end of the section. Both street cars and other vehicles have to move in single file in one direction at a time. A temporary board walk fenced in on both sides, is provided for pedestrians in the center of the roadway, alongside the section torn out. Two temporary street car crossovers were installed at the east end of the work in order to reduce the length of single track over which the cars have to operate in both directions. Traffic has been maintained satisfactorily, and although at times the congestion becomes rather heavy, there have been no serious delays.

All work is being done by the forces of the Terminal Railroad Association under the direction of B. B. Betts,

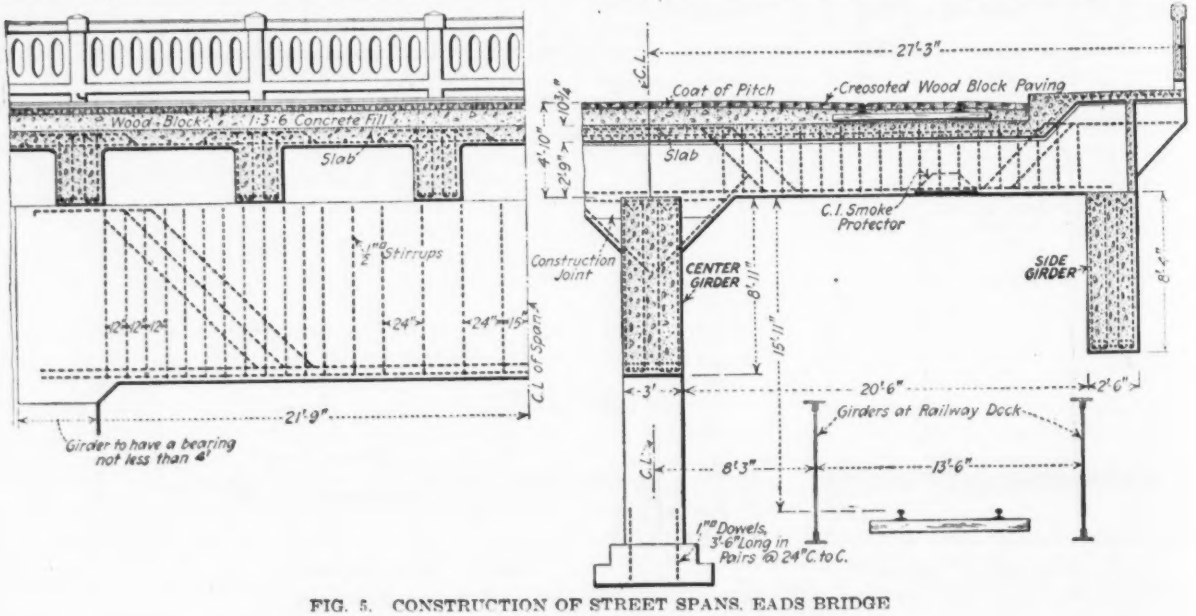
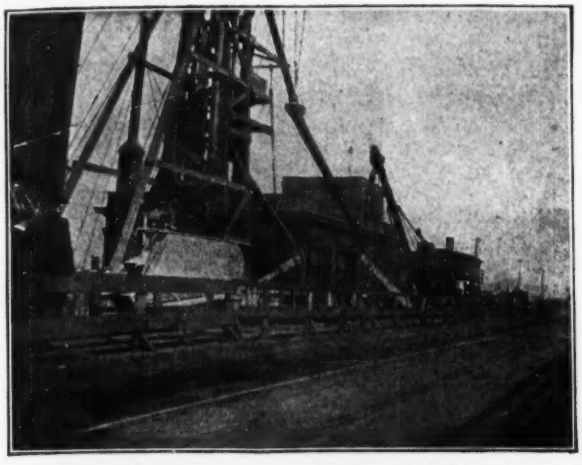


FIG. 5. CONSTRUCTION OF STREET SPANS, EADS BRIDGE



CONSTRUCTION PLANT FOR REBUILDING DECK OF BRIDGE APPROACH

superintendent of construction. The new deck was designed by the writer under the direction of H. J. Pfeifer, chief engineer. A 50-ton street car, placed in any position, with an allowance of 25 per cent for impact, was the assumed live loading for the roadway, while the sidewalks were designed to carry a superimposed load of 100 lb. per square foot. The estimated cost of the work is $160,000. By December, 1920, the north half of the structure had been completed and operations are now suspended until the spring of 1921.

Some Things to Be Learned About Concrete

The Committee on Research of the American Concrete Institute in its report to the recent convention gives the following subjects that need study in the field of concrete:

1. Proper methods of measuring quantities going into a batch of concrete.
2. Collection and correlation of data to show quantity of set concrete which can be made from given amounts of different aggregates.
3. Establishment of a standard screen scale for concrete aggregates and limits of variation in sizes of different classes of aggregates.
4. A standard field method for determining consistency of concrete.
5. A standard field test for strength of concrete.
6. Tests to ascertain the efficiency of various types of mixers in making concrete.
7. The allowable variations in sizings of aggregates.
8. An index of quality of aggregates as determining their value in concrete.
9. An abrasion test for gravel.
10. The production of plant-mixed aggregate.
11. A method of evaluating various forms of mechanical anchorage of reinforcing bars in reinforced-concrete beams and slabs.
12. The value of clay tile built in with concrete beams in adding to the shearing resistance of the beam.
13. Relative values of rectangular and T-shaped or I-shaped reinforced-concrete beams in resistance to shear.
14. A method of evaluating bent-up bars as shear reinforcement for concrete beams.
15. A study of corrosion in reinforcement in contact with salt water or salt air.
16. Bond stresses in two-way reinforcing, as in footings.
17. Adjustment of steel stresses due to plasticity of concrete.
18. Test of chuted concrete.
19. Central mixing plants.

Mechanical Equipment Speeds Snow Removal

Fall of 12½ Inches in New York City Attacked With Caterpillar Tractors, Blade Graders and Motor Trucks

EXTENSIVE use of mechanical equipment, in contrast to the hand-labor methods of previous years, a plentiful supply of emergency labor and advance planning by the Department of Street Cleaning, resulted in the speedy opening up to traffic of New York City's streets, following a severe storm which deposited 12½ in. of snow in 23 hours, beginning on the night of Saturday, Feb. 19. The storm called into service for the first time the "tank" type tractors, blade graders, push plows and motor trucks for which (including a number of garages) $4,000,000 had been authorized last summer. While this year's storm did not approach in severity or in the density of the snow the one which caused a tie-up of traffic for weeks last winter, it was of a character to demonstrate the effectiveness of the city's new methods of snow removal.

PLOWING STREET WITH MOTOR TRUCK

According to the records of the U. S. Weather Bureau at New York, the storm began at 11:25 p.m. Feb. 19, and lasted until 10:05 p.m., Feb. 20. The amount of snow which fell during the 22 hrs. 40 min. was 12½ in., the density being 0.21, or 13 lb. per cubic foot.

There are scheduled for snow removal in the Boroughs of Manhattan, the Bronx, and Brooklyn 951 miles of streets or a surface area of 33,000,000 sq.yd. Snow removal in the other two boroughs of the city, Richmond and Queens, does not come under the jurisdiction of the Department of Street Cleaning. The storm of Feb. 19, therefore, presented to the department the problem of disposing of about 11,500,000 cu.yd. of snow. The work was handled by a force of about 20,000 men, of which 4,000 are the regular employees of the department, 13,000 emergency laborers, and 3,000 hired by the snow-removal contractors. The methods of removal involved carting to river dumps and disposal into the city's sewerage system.

For purposes of administration, the city is divided into districts and the work handled from street cleaning headquarters through district superintendents. For the contract removal of snow agreements are entered into generally during the previous summer. Emergency labor is secured by a campaign of advertising and publicity in the daily press and the moving picture theatres, in addition to a system of registration of available men who are called out, by precincts, through the co-operation of the Police Department. This year, in contrast to last, the supply of labor for snow work was plentiful, due to the general slowing up of industrial activities. In fact, when the first call for men was made the hourly rate of pay was 65 cents, but as the work progressed and the number of applicants for jobs increased the rate was reduced to 50 cents an hour. The regular department employees received $5.60 a day (for drivers) and $5.21 a day (for sweepers). The contract work is let on a unit price basis and varies in different parts of the city, depending on the length of haul, but a rough average price for this year's work is about 52 cents per cubic yard. The emergency workers reported at the department's 103 stations in various sections of the city where men seeking work were assigned to duty and given badges, tickets and tools.

MECHANICAL LOADER FILLING MOTOR TRUCK

CLEARING STREET WITH TRACTOR AND BLADE GRADER

The use of mechanical equipment was the outstanding feature of this winter's snow removal work. Following the authorization of an appropriation of $4,127,000, the Department of Street Cleaning, acting in accordance with recommendations of a committee on snow removal consisting of engineers and department heads in the municipal service, purchased the following machines:

MECHANICAL EQUIPMENT

212 5-ton, 6-cu.yd. White motor trucks (of which 75 have interchangeable bodies for the substitution of flushing equipment).
100, 2-ton, 3-cu.yd. Mack motor trucks.
100 Cleveland tractors, each weighing 2 tons.
500 Holt caterpillar tractors, each weighing 4 tons.
150 Climax blade graders.
300 Champion push plows.
1 Friedman snow loader.

In addition a Barber-Greene mechanical loader, equipped with a special conveyor frame and belt, was used experimentally for transferring piled snow to motor trucks; funds for buying one of these loaders have been authorized. The storm also brought forth the usual claims for snow-melting devices.

The storage of the department's mechanical equipment presented a problem, inasmuch as a number of garages, provided for in the appropriation previously referred to, had not been made ready. The "tank" type tractors were assigned to various Fire Department stations, while a large number of the motor trucks were housed by taking over the East 24th St. Pier, a structure 725 ft. long, building a ramp to the second story, and utilizing it as a garage. Where possible, motor trucks were stored at Street Cleaning Department stations.

Until this year, the department had practically no mechanical equipment and it was, therefore, necessary during the summer time to train the regular drivers as chauffeurs. A school was established for this purpose. Instruction was given also to Fire Department employees, to whom was assigned the duty of operating the caterpillar tractors.

A schedule for tractor and truck operation during snow storms was prepared last summer. On a large-scale map of the city, routes—in most cases about 3 miles long—were laid out for every machine and marked in different colors so that when the storm signal was given, each driver of a tractor or truck had already received his orders and needed no further instructions. As a supplement to the map there were distributed to each driver printed directions specifying in detail the route that he should follow with his machine as soon as the alarm sounded. With the giving of the storm signal, therefore, much of the machinery of snow removal is put into operation automatically.

The plan of attack mapped out involved the use of all available mechanical equipment during the early period of a storm for operating push plows or blade graders, in order to open up paths for traffic by shoving the snow either toward the curbs or into the center of the street, depending on its width and location. The 5-ton trucks were equipped with push plows having 10-ft. blades, while the Cleveland tractors hauled blade graders, also provided with 10-ft. blades. The Holt

tractors were equipped with 10-ft. push plows. The tractors and their pull-plows are always operated in pairs, one following behind the other. The small tractors are equipped, however, to carry an 8-ft. push plow, but the plans provide for the use of this equipment only after traffic lanes have been opened up, the push-plows on the small tractors being designed for shoving snow to manholes, not clearing traffic lanes.

The small tractors operate at a speed of from 1 to 3½ miles per hour and are equipped with a 20-hp. engine. They are rated to pull 1,284 lb. at the 3½-mile speed. The length of tractive contact on each side is 50 in., and the width 8 in. The machines are standard equipment except for the addition of a cab for the protection of the driver, as shown in the accompanying photograph. The 5-ton trucks are used for plowing until the storm is well in hand; then the plows are detached and the trucks are employed for hauling snow from loading points to dumps.

DEPARTMENT'S NEW TRUCKS OFFER LOW LIFT FOR SHOVELERS

Mechanical Loading Tried

The motor trucks, it will be noted from one of the pictures, have a low body designed especially to minimize the lift (about 5 ft.) in hand-loading with shovels. While the bulk of the snow carried by trucks was loaded by hand, mechanical loaders were given an experimental try-out. The Barber-Greene machine, shown in one of the photographs, consisted of an inclined conveyor equipped with a special cleated belt and carried on caterpillar tracks. This machine was backed into the snow piles, a motor truck following along underneath the discharge end of the conveyor. During a period of four hours, this device loaded about fifteen trucks per hour, each truck carrying about 5 cu.yd. One operator is required to run the machine and another to break down the snow at the charging end so that the belt may be properly fed. The motor truck operators during this test were new at the work and did not always spot and back up their machines to best advantage. With more experience in co-ordinating the work of the loader and the receiving truck, it is believed by Street Cleaning Department officials that a much higher rate of loading than that actually recorded can be realized. Sometimes a 5-yd. truck was loaded in less than 2 min. A further increase in effectiveness can be secured by using side-boards on the low bodies of the trucks, thus increasing their yardage and reducing the lost time in backing up and pulling out at the beginning and end of each loading.

For recording the yardage of snow removed by the contractors each vehicle is measured and its capacity computed. It is placarded with a number and the driver is issued a card in triplicate, which is punched both at the loading point and the dump. Punches with different shaped dies are employed and are changed about by inspectors at frequent intervals to prevent possible collusion between drivers and foremen. At the end of each day's work these cards are turned in to Street Cleaning Department headquarters where the clerical force examines and checks them and makes the necessary extensions to compute the yardage and amounts due the contractors.

During the recent storm, both a night and day shift were worked and although it was close to midnight when the orders for snow removal work were issued, practically all of the mechanical equipment was manned and in operation within a few hours. No serious interruptions to the movement of the traffic on New York City's streets resulted, in spite of the fact that more than one foot of snow fell in less than a 24-hour period.

The work was done under the direction of J. P. Leo, Commissioner, Department of Street Cleaning, with a snow removal staff headed by A. A. Taylor, general superintendent, J. J. Condon, superintendent and H. Hart, assistant superintendent, snow removal division, and E. C. Goodwin, examining engineer.

Rods vs. Expanded Metal for Slabs

Tests on two slabs, 10 ft. square and 5 in. thick, made by F. A. Simmons, Assistant Professor of Civil Engineering of Carnegie Institute of Technology, give some data on the relative behavior of rod and expanded metal reinforcement for a slab supported on four sides. One slab was reinforced with ½-in. round rods, 6 in. c. to c. in each direction, which gives an area of 0.392 sq.in. per foot of width in each direction and a gross weight per square foot of 2.672 lb. The other was reinforced with expanded metal laid in one direction and weighing 1.40 lb. per square foot or 0.384 sq.in. per foot of width.

In the rod-reinforced slab the first cracks were observed when the load per square foot on the slab was 661 lb. At this point a deflection at the center was observed of 0.19 in. In the expanded-metal slab, the first cracks were observed at 713 lb., when the center deflection was 1.05 in. and as the previous readings indicated rapidly increasing deflections it was decided not to continue the loading to complete failure. In the other slab the total load obtained was 1,153 lb. per square foot. The last deflection taken on the next to the last load gave 1.09 in.

The concrete tested from 2,600 to 3,060 lb. per square inch in compression, in cylinders poured from the same batches as the slabs.

Plant and Equipment for Lining The Selkirk Tunnel

Pneumatic Concrete Placers Mounted on Cars Being Used to Line Five-Mile Canadian Pacific Ry. Tunnel Through Selkirk Mountains

BY THE STAFF OF SYDNEY E. JUNKINS CO., LTD.
Vancouver, B. C., and Winnepeg, Man.

WORK is now under way in the lining with concrete of the five-mile double-track tunnel of the Canadian Pacific Ry. under the Selkirk Mountains near Rogers Pass. This pass gave the name to the tunnel in its construction period but it is now known as the Connaught Tunnel. The operations will involve some 20,000 lin.ft. under main line traffic conditions, so the construction plant and equipment have presented somewhat exceptional problems. To them may be added an altitude at the tunnel of 4,000 ft. above sea level, an average snowfall during the winter of 40 ft. and a distance of 220 and 420 miles to the nearest cities where materials, equipment and labor can be obtained.

The principal requirements for the plant are as follows: (1) Storage and handling of material outside the tunnel. (2) Transportation of men and material into and out of the tunnel. (3) Lighting. (4) Mixing and placing concrete.

MATERIAL STORAGE, OFFICE, POWER HOUSE AND CAMP AT WEST PORTAL, CONNAUGHT TUNNEL

The plant itself had to be laid out with special consideration to safety, non-interference with railway operation, non-interference with signal and other circuits, fire hazard, reasonable and economic speed in performance and special weather conditions in the mountains. Practically every variety of layout was considered to take care of the above conditions.

It was decided to construct a central electric generating station which should supply power sufficient for brilliant lighting of the working zones within the tunnel and for the operation of a plant mounted on cars, consisting of air compressor with its operating motor and auxiliary apparatus, storage space for the materials for the aggregate, and motor operated mechanical premixing and air-placing concrete apparatus. A transmission line to the working zones, transformers, low tension lines to the lights and motors, and a gasoline locomotive for hauling this plant and the supply cars were the necessary adjuncts of the plan.

The heart of this scheme is the electric power plant which is located near the west portal of the tunnel at Glacier station. On account of the topography it was not feasible to place the power plant at main line level, and it was therefore located on an embankment south

WORK TRAIN WITH 27-TON GASOLINE LOCOMOTIVE, ROCK SCALING AND DERRICK CARS

of the railroad. A high line with a switchback permits the delivery of coal in carload lots, while water is made available both from a gravity camp supply and from the Illecillewaet River, which flows by the power house.

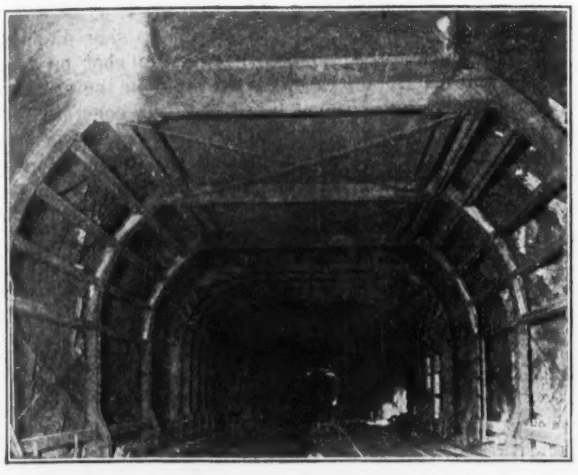
The power house is a frame structure on concrete foundations, and is divided into the usual engine and boiler rooms. An overhead coal trestle permits the delivery of coal direct to the firing floor, while storage space for 1,000 tons for winter operation is also provided, the last to reduce the cost of keeping the high line open during the heavy winter snows.

In the interests of economy three old locomotive boilers were fitted up and installed with forced draft blowers, separate stacks and breeching. Steam is turned from each boiler into a common header and thence led to two direct connected, simple, horizontal, non-condensing engine generating units each of 150 kw. nominal capacity. These units are connected through a simple three-panel switchboard and can be run separately or in parallel. Separate circuits are provided for light and power.

During the driving of the tunnel pioneer tunnels about 7 x 8 ft.-in cross section were driven from each end parallel to and about 50 ft. from the main tunnel for a considerable part of its length, the west pioneer tunnel being some 9,000 ft. long. Crosscuts from the pioneer to the main tunnel were driven at about 1,500 ft. intervals and the pioneer tunnels were used for the passage of men and materials and the removal of spoil from the main headings. These pioneer tunnels were a considerable factor in the extraordinarily rapid progress during tunnel construction.

The pioneer tunnel, so far as it reached, provided an ideal space for the stringing of the high tension transmission line, eliminating all possible interference with traffic in the main tunnel for nearly two miles and by the use of bare wire making material savings over the cost of lead covered cables.

Two three-phase circuits are led from the power house at 2,200 volts a.c. on a wooden pole line above ground for a distance of some 2,200 ft. to the entrance of this west pioneer tunnel; thence through the pioneer tunnel about 9,000 ft. to the last or sixth crosscut between the pioneer and main tunnel. From the sixth crosscut the transmission line is carried in lead covered cables in the main tunnel about 3,600 ft. to the trans-



PIONEER FORM IN FOREGROUND AND CONCRETING FORMS BEHIND

former bays, whence the lower voltage current at 110 volts for light and 550 volts for power is distributed approximately 2,000 ft. in each direction throughout the present working zones. The low tension distribution system is provided with outlets about every 100 ft., to which the power and the light apparatus can be readily attached as needed.

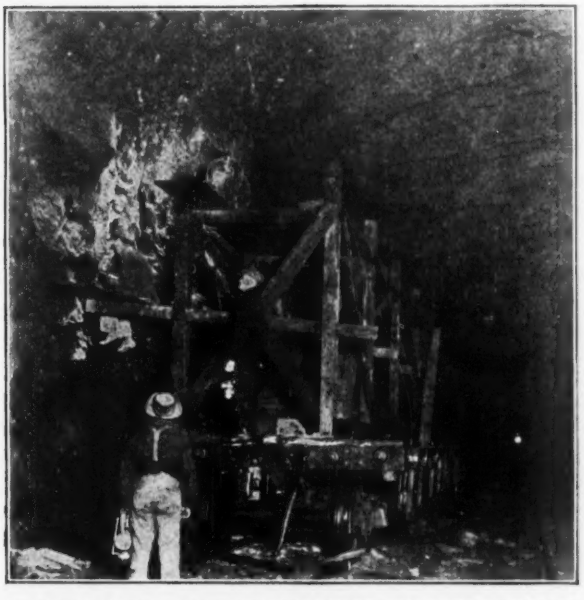
Immediately after the passage of trains, particularly when operating against the 1 per cent grade in the tunnel, smoke conditions make work extremely difficult. Most careful consideration was given to a variety of schemes for illuminating the working sections under smoke conditions and at the same time for not over illuminating the work after the smoke had cleared. Numerous laboratory experiments were made. Flood lights of 500 watt capacity each were finally decided upon. These lights are portable and adjustable as to diffusion of beam, and have been found to work out in practice exceedingly well, permitting illumination to be varied immediately to meet any particular set of conditions obtaining in the tunnel at any time. They also have largely cut the time lost due to smoke and show a large saving in labor costs.

Two 75-ton pit flat cars were coupled together to carry the concrete mixing and placing apparatus. On one car is located a 1,290 ft. motor driven compressor, while on the other car are located a mechanical concrete mixer of 22 cu.yd. per hour capacity and a pneumatic placing apparatus of the same capacity manufactured by the Ransome Concrete Machinery Co. Storage bins for sand and gravel are provided on each car with a belt conveyor to carry material from one car to the other. Cement storage is located convenient to the mixer, and water tanks are provided. All storage is calculated on a basis of blowing a complete form without coming out of the tunnel to recharge. Sand and gravel are delivered to the mixer skip by gravity and the mixed concrete drops by gravity into the air placer. Necessary pipe and flexible hose connections to the forms are also installed.

In operation the cars are spotted near the form to oe blown, are jacked up in order to take the weight from the springs and electrical power connection is made to the nearest outlet on the power distribution line. No difficulty has been experienced with vibration or rocking, although the compressor motor has a capacity of 200 hp. at 514 r.p.m.

A 27-ton gasoline locomotive is used. Its duties are varied and include the handling of the mixer cars in and out of the tunnel, the handling of rock scaling and derrick cars, material cars, switching of cars in the yard and to the high line, switching of material cars to the storage sheds, running of lunch cars into the tunnel in order to save working time otherwise consumed by the men going out for lunch, and in general the many miscellaneous switching uses continually arising on work of this kind. The machine is rated to handle 210 tons on a 1 per cent grade and is operated by one man.

An electric locomotive would have imposed excessive costs and a steam locomotive would have aggravated



ROCK SCALING CAR AND WORKMEN SCALING TUNNEL WALLS WITH ELECTRIC DRILLS

smoke conditions in the tunnel. The effect of the exhaust gases from the gasoline locomotive was carefully considered but found to be negligible.

On account of the usual overbreak in building the tunnel a considerable amount of false formwork has been found necessary. Space back of the false forms is now packed with cordwood lagging. A search is being made for other material which may be found cheaper to put in place. A large amount of overhead work is involved in fastening the false forms to the roof, in packing the lagging, in placing reinforcing and in scaling rock. Six rugged movable platforms on wheels have been built of light steel frame and timber for this overhead work. They clear traffic and hold considerable amounts of construction material as well as the workmen. Each of these platforms handles the advance work for one main form.

The main forms are six Blaw-Knox collapsible steel forms, each providing 20 ft. of finished tunnel lining at one placement. These also clear all traffic. Each form is on wheels, and after the concrete is blown and set the top plates are collapsed and the form rolled forward to its new position.

Because of excessive snowfall all material has to be carefully housed. A 5,000-cu.yd. gravel bunker is installed, the gravel being dumped by gravity from cars on the high line. Gravel is handled into the mixer car by bucket conveyor. Steam apparatus is provided to prevent the gravel from freezing. Sheds for cement, reinforcing steel, lagging and lumber storage are located conveniently for delivery direct from cars.

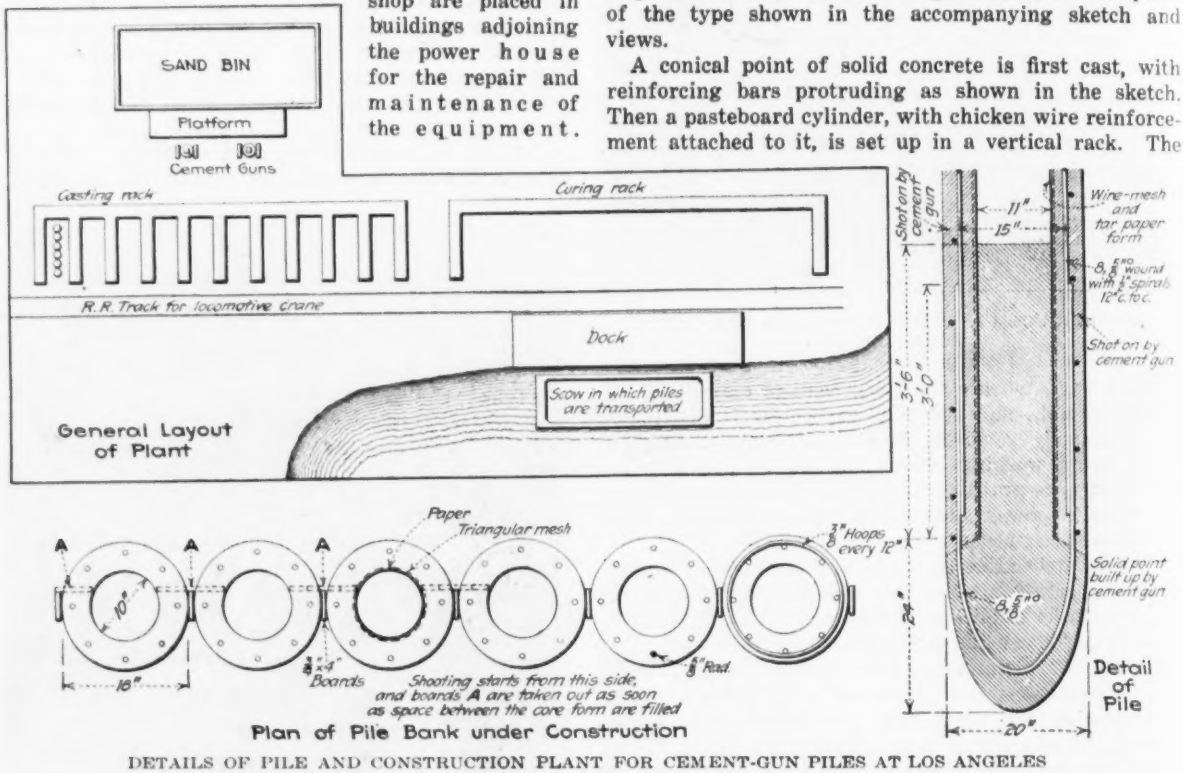
A small motor-driven machine shop and a blacksmith shop are placed in buildings adjoining the power house for the repair and maintenance of the equipment.

Long Concrete Piles Built Up With Cement Gun

Bullet Nose Point First Formed and Hollow Shaft Joined to It by Shooting Concrete on Paper Form

FOR sea-water work in Los Angeles Harbor the city of Los Angeles is now building about 1,200 reinforced-concrete piles from 42 to 60 ft. long of hollow cylindrical section and 18 to 20 in. outside diameter by building up the shell with concrete shot on by a cement gun. Deterioration is so rapid in the southern Pacific waters that some more compact concrete than can generally be made by ordinary process was desired. Experiments with the cement gun led to the adoption of the type shown in the accompanying sketch and views.

A conical point of solid concrete is first cast, with reinforcing bars protruding as shown in the sketch. Then a pasteboard cylinder, with chicken wire reinforcement attached to it, is set up in a vertical rack. The


SAND BIN
Platform
Cement Guns
Casting rack
Curing rack
R.R. Track for locomotive crane
Dock
Scow in which piles are transported
General Layout of Plant
Paper
Triangular mesh
Boards
Shooting starts from this side; and boards A are taken out as soon as space between the core form are filled
Plan of Pile Bank under Construction
Shot on by cement gun
Wire-mesh and tar paper form
Shot on by cement gun
Solid point built up by cement gun
Detail of Pile

DETAILS OF PILE AND CONSTRUCTION PLANT FOR CEMENT-GUN PILES AT LOS ANGELES

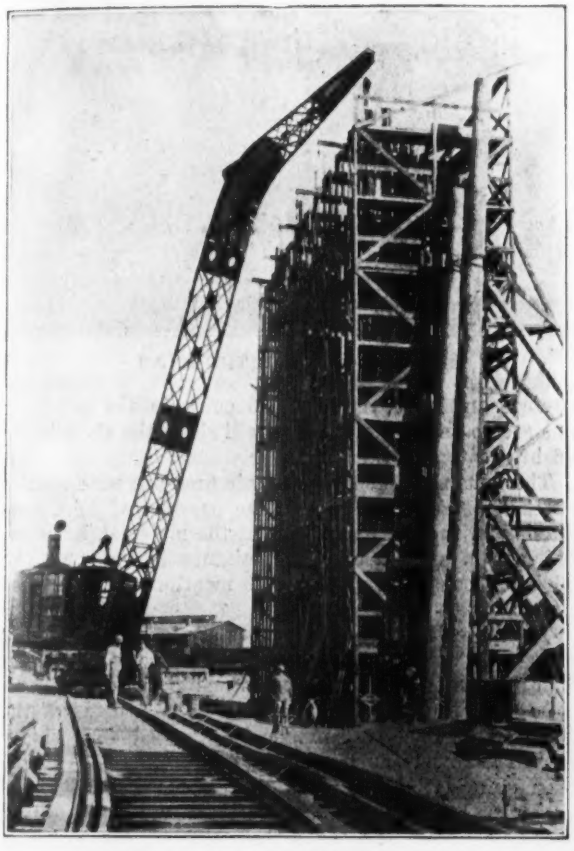
The proper and comfortable accommodation for 200 men in the heart of the mountains has been an important and difficult question. A complete camp complying with Government regulations has been gradually built up, consisting of sleeping quarters, subdivided into units of four men each, bathhouse and laundry, separate small houses for married men, community dining room, kitchen, store houses and roothouse, a total of about 60 buildings. All quarters are electrically lighted and provided with water. Heat is furnished by stoves. A drainage system and a septic tank have been installed.

The work has been done under the direction of the Canadian Pacific Railway Engineering Department, Western Lines, W. A. James assistant chief engineer, Frank Lee, engineer maintenance-of-way, and H. Rindal, district engineer. Mr. James represented the railway company on the ground as engineer of construction in charge of the driving of the tunnel.

The Sydney E. Junkins Co., Ltd., of Winnipeg and Vancouver, is doing the construction work.

4 or 4½-in. granite annular ring is then applied to the outer surface of the pasteboard, the rack being of such a nature that the workmen can use the nozzle all around the pile. The piles are then left in the rack to cure for about two weeks, after which they are taken from their vertical position and stored inclined vertically. By constructing, curing and storing the piles in a vertical position, it was reasoned (1) that bending stresses and the attendant cracks would be avoided and the resultant light, hollow pile would have adequate strength, while (2) the dense concrete which it was claimed would be secured with the cement gun would give a surface more impervious to sea water than would piles cast in the usual manner. Under conditions of maximum loading the piles are expected to carry a load of about 20 tons each.

The piles are built up in a so-called shooting-frame, a wooden scaffold-like structure made up of a series of eight floors about 6 ft. apart and divided in plan into ten bays. Each bay has a clear opening for its full



CASTING RACK FOR CONCRETE PILES

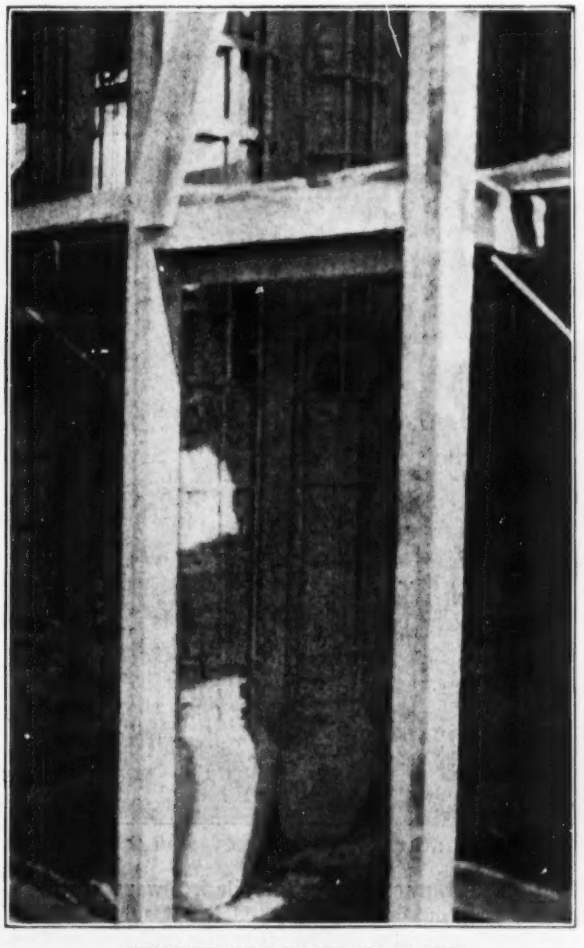
height on the front of the structure along which a railroad track runs. The bracing and anchorages are provided at the back. The bays are made large enough to accommodate six piles each, this number being made up at a time.

The noses which are made first are about 5 ft. 6 in. total height, the upper 3 ft. 6 in. being a cylindrical stem 10 or 11 in. in diameter, depending upon the length of the completed pile, and the lower 2 ft. in height being a bullet-shape or tapering nose with its upper diameter from 18 to 20 in. There are eight ⅞-in. round rods in the base which project about 3 ft. above the collar in order to provide for a lap of full length steel. When the bases have set sufficiently they are placed six in a row in the blowing rack, and the tar paper collars 10 or 11 in. in diameter placed around the stem of the base then wrapped with triangular mesh, then the full length vertical rods placed on a 15-in. diameter circle around the pile. When wrapped the piles are ready for blowing.

The paper cylinders or cores are made on a collapsing mandrel on which there is first wrapped a strip of building paper of a quality which weighs 35 lb. to the 500-sq.ft. roll. This strip of paper is placed lengthwise on the mandrel and a light wire is wound around it on a 4-in. pitch. Over this is then wound a strip of building paper 6 in. wide with a 3-in. pitch which gives a spiral winding with several thicknesses of paper at all points and makes the paper cylinder stiff enough so that it readily holds its strength when the mandrel is collapsed and removed. While this strip of paper is being wound, a trough of fish glue which is kept hot beneath the lathe is kept in contact with the winding surface in such a way that the paper strip is rigidly glued in place. After being taken from the mandrel, the paper cylinders which are about 12 ft. long are allowed to dry and are then covered with wire mesh. The mandrel is made with a slight flare at one end and contraction at the opposite end so that the successive paper sections will fit together in bell and spigot fashion.

Piles under 50 ft. have an outside diameter of 18 in. with 4-in. walls leaving a 10-in. hollow core; those above 50 ft. are 20 in. outside diameter with 4½-in. walls and 11-in. core. In all piles the vertical reinforcement consists of eight ⅞-in. vertical rods encircled by a heavy wire-mesh cylinder. This latter supplants the earlier design of ⅜-in. spiral hooping on 12-in. rise, which proved inadequate in construction.

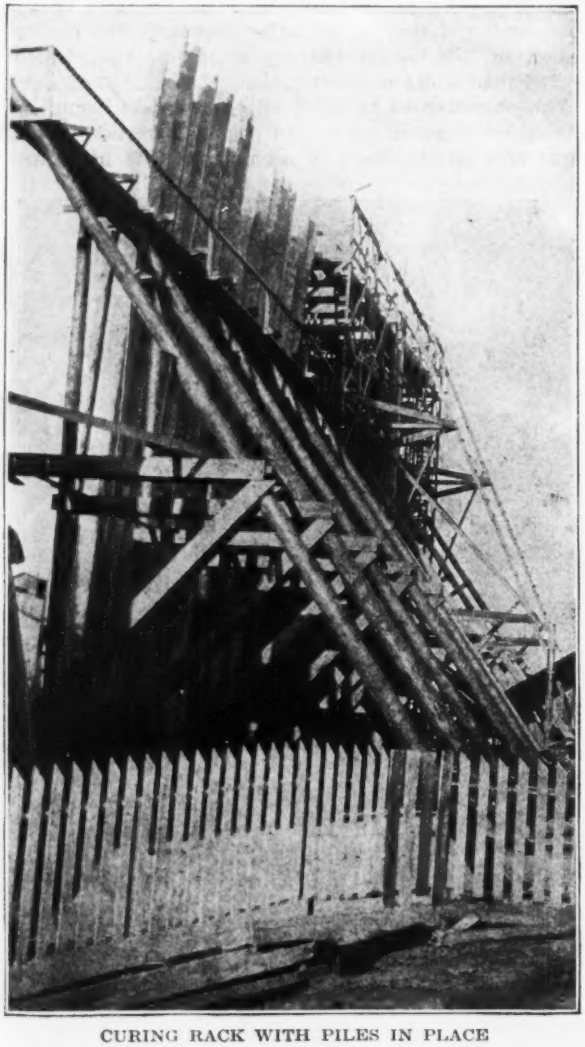
The operation of building up the piles is begun by setting six noses in a bay and placing a section of the paper core on the shaft of each nose. The noses are



PRECAST PILE NOSES IN PLACE

set in a row and spaced so there is 8 in. between the paper cores of adjoining piles, thus allowing room to enclose each core with a 4-in. wall. A board partition is set up in the space between adjoining cores to provide a backing against which to throw concrete. This partition is put on in sections of about the same height as the paper cores and is removed just before the final work on each section. At the middle of each partition and at right angles thereto, a single thin strip of wood is placed to prevent the piles from bonding.

The man operating the cement gun nozzle begins at the bottom and works upward from floor to floor. One section is finished at a time by going entirely around the cluster of six piles before moving to the section above. After the piles have been allowed to stand for 11 to 15 days, they are picked up, one at a time, by the locomotive crane and placed in the adjoining curing rack, still in a vertical position. Here they are left for another 30 days. A scow with a rack built upon it, similar to the curing rack, is used for conveying the piles from the yard to the point where they are driven,



CURING RACK WITH PILES IN PLACE

about 2,000 ft. away. Thus the pile is always kept in a vertical position, or nearly so, and is not subject to the cross bending strains incidental to the ordinary method of handling piles that have to be raised from the horizontal position in which they are cast.

The capacity of the plant is at present six piles per day, these six piles consisting of two 60 ft., one 56 ft., one 53 ft., one 49 ft. and one 42 ft. The operating time is 5½ days per week, therefore, the weekly capacity should be 33 piles; however, on account of delays such as bad weather and other causes their average production is 25 piles per week. There are two cement guns each with a nozzleman and two men in his crew, with three men on the plant. There are 1,626.5 sq.ft. of

SOLID NOSES FOR THE PILES

surface and approximately 350 cu.ft. in the piling in one set-up and one nozzleman will shoot the six piles in 16 hr., or two working days.

The guns work under 35 lb. air pressure with nozzles specially designed to permit the passage of ½-in. rock maximum, the big percentage of the material, however, being ⅜-in. and under. The mixture is 1:1½:2½, the 2½ being composed of this last mentioned coarse pea-gravel.

The material in which the piles are being driven consists chiefly of silt and detritus, and there is a penetration of from 18 to 30 ft. By means of two 2-in. water jets, the piles are jetted down about two-thirds of the required distance, a hammer being used for driving them the remaining distance. The driving so far has been quite satisfactory and the piles are standing up under the battering and the load. Should it be desired ever to fill them and make them solid it should be an easy matter to do.

The design of these piles and the method of construction were both worked out by J. W. Ludlow, assistant harbor engineer under John A. Griffin, city engineer of Los Angeles. Mr. Ludlow was assisted by V. R. Sterling and F. W. Wadleigh.

Photographing Road Plans

By Neil F. Hathway
Highway Engineer, Montcoal, W. Va.

CARRYING a large roll of road plans while staking out or inspecting road construction is quite often a great inconvenience. The blue prints soon become soiled and torn and one set will hardly last through a season. To get the plans into pocket form the engineer often extracts from the roll the sheets that he expects to need that day and folds them into a convenient size. In the course of a few weeks the plans are creased, dirty and so disarranged that considerable time is often lost in finding the sheet desired.

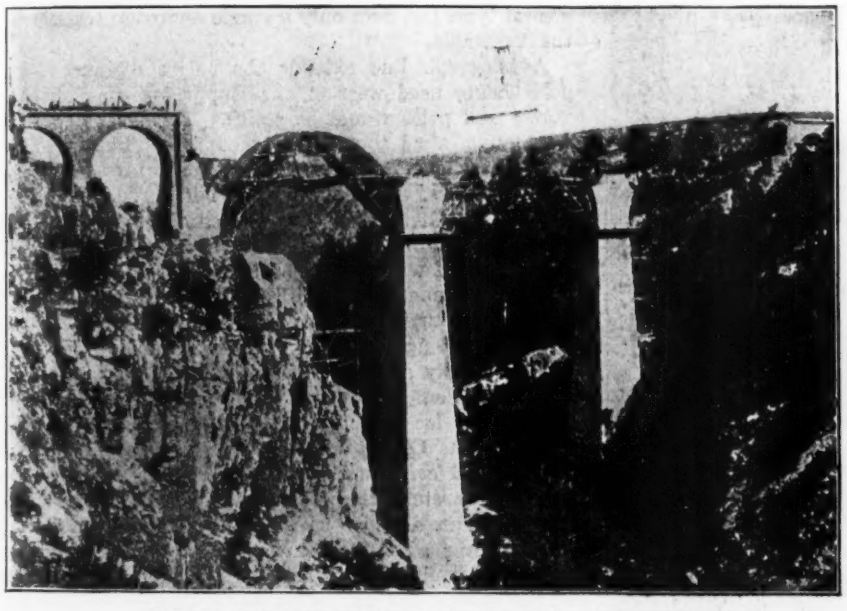
To do away with the inconvenience of a large roll of blue prints for field use I photographed the tracings with a 3A kodak. For this purpose a sheet was tacked against the outside of the office building to give a white background and the tracing fastened to this. Although, due to inexperience, I failed to take full advantage of the size of the film, the photographic prints were so clear that practically all details were plain to the naked eye. With the aid of a small reading glass the print is as easily read as the full-sized blue print (22 in. x 36 in.).

These prints can be placed in the field note book. The cost was much less than the cost of blue prints.

The Bagdad Railway—An International Problem

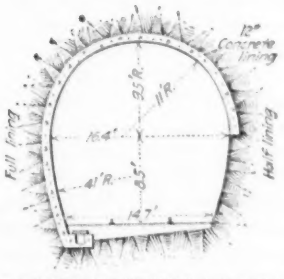
Uncompleted 2,000-Mile Line Across Asia Minor To Form an "Overland Route" to India—Heavy Tunnelling—Fortified Stations

A PROMINENT side issue of the World War was the German attempt to open a route between Central Europe and Asia, with the unfinished Bagdad Railway as a link across Asia Minor. This project was thoroughly defeated. With the international changes and complications following the war this railway line has become of special importance and it is evident that it will eventually play a part in the development of the Far East by European enterprise. Little information has been available concerning the progress of the line. Articles describing the work have appeared in *The Engineer*, London, by Major Derwent G. Heslop, Royal Engineers, who during the war was the British officer in control of the Bagdad, the Hedjaz and the Damascus railways. The railway and its connections are shown on the accompanying map. The following is an abstract of Major Heslop's account:



BUILDING STONE VIADUCT OVER THE GIAOUR DERE

British projects for a railway between the Mediterranean Sea and the Persian Gulf, giving a short "overland route" to India, date back to 1831 and include several alternate locations through the Tigris and Euphrates valleys. In 1888, the Sultan granted to a German company a concession for a line from Angora to Mosul and Bagdad, but owing to objections from the Russian government the route was changed to run from Konia to Mosul, although this new location, based upon political considerations, involved heavy work in crossing the Taurus and Amanus mountains which border upon the Mediterranean. In 1895 a further concession was granted for an extension south to Basra and thence to a port on the Gulf, but on protest of the British government this was modified to exclude Germany from the harbor at Koweit and from the oil fields in the Delta of the Euphrates. At present the southern part of the line is held by the British and the northern part is under control of the French; Turkey has the connection to Constantinople and Greece, in part at least, has control of the Smyrna connection. It will be seen by the map that there is a gap of about 200 miles between the two sections and that the extension to the Gulf remains to be built, the Bagdad terminal being served by steamers and barges on the Tigris.



TUNNEL SECTIONS ON THE BAGDAD RAILWAY

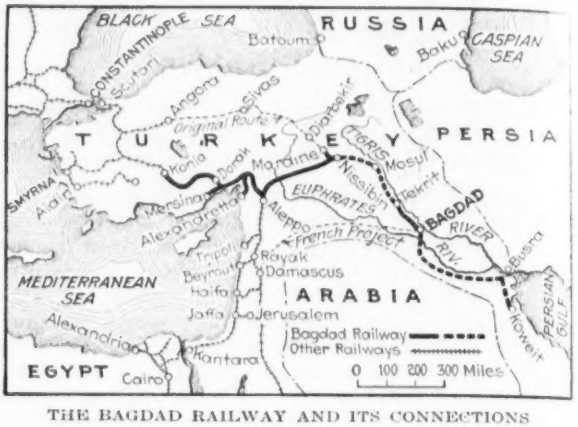
Only the narrow strait of the Bosphorus separates the European railway system terminating at Constantinople from the Asiatic line starting near Scutari and extending to Konia, reached also by a line from Smyrna. From Konia to Boulgourlu, 124 miles, the Bagdad railway traverses a plateau at an average elevation of 3,280 ft., but in the next 80 miles to Dorlak it crosses the Taurus range, reaching a summit elevation of 4,840 ft. near Ouloukichla. It then crosses a coastal plain at 72 ft. elevation for 87 miles to Mamoure, where it begins the 34-mile crossing of the Amanus range, reaching an elevation of 2,430 ft. in the Airan tunnel and descending to Islahie, whence it extends 92 miles through rolling country to Muslimie. For 265 miles the line then runs through easy country, crossing the Euphrates, and extending to Nissibin, the present end of the northern section.

From Bagdad the line was built 116 miles north to Tekrit, but before the war no work had been done on the next 143-mile stretch to Mosul. In 1918, the British-Indian army in its campaign against the Turks extended the line some 50 miles north to Baiji, using rails made in India and operating the Bagdad-Baiji section with rolling stock from the Indian railways. During 1919-1920 a further extension was made to within 40 miles of Mosul, but it is reported that this part of the line has been cut by the insurgents. Between Mosul and Nissibin, 125 miles, some grading has been done, but there is a gap of over 200 miles to be filled to complete the rail connection between the two seas. Four branch lines aggregate 88 miles: Yenidji to Mersina, 27 miles; Toprak Kale to Alexandretta, 37 miles; Muslimie to Aleppo, connecting with Syrian lines, 9 miles, and Derbissie to Mardine, 15 miles.

Long maximum grades of 2.5 per cent occur in the

mountains, the grade being reduced to 2.3 per cent on curves of 1,300 (the minimum) to 2,600 ft. radius. Transitions or easements are used on all curves up to 4,900 ft. radius. The gage is 4 ft. 8½ in., as on the connecting lines. Flange rails of 75½ lb. per yard, in lengths of 39 ft. 3 in., are carried on 115-lb. steel ties of trough section, there being 16 ties to a rail, or 18 on the heavy grades. Six-bolt, 33-in. splice bars have short bottom webs between the joint ties, which are spaced 21½ in. c. to c. Tapered tie-plates have hooked lugs to hold the outer flange of the rail, the inner side being secured by clips and nuts on T-head bolts.

Much damage has been done to rails and ties by operating construction trains over unballasted track on soft roadbed. Many cuts were not excavated to full section and there is trouble from material sliding and



THE BAGDAD RAILWAY AND ITS CONNECTIONS

THE CHAKIT RIVER GORGE

falling. Maintenance work at many points has been neglected greatly, but on the whole the line is in fair condition.

Manual interlocking signals are provided at stations, with steel semaphores on lattice steel posts, the home signals being 328 to 656 ft. from the station and the distant signals 1,640 to 2,300 ft. beyond. Where no stations have been built there are passing sidings at intervals of about 12½ miles.

Stations and other buildings are of stone masonry, those east of the Euphrates being fortified against the attacks of wandering bands of Bedouins. Water, obtained mainly from wells, is pumped by hand or power to steel tanks on steel towers. To facilitate spotting the engines at water columns, the tender has a slot the full length of one side of the top, instead of having a manhole. Between Konia and Nissibin there are repair shops at eight points and engine houses at fourteen points. The latter are of the American segmental type, but with only a single approach track over the turntable.

A telegraph line extends the entire distance, iron poles being used west of the Euphrates as timber is scarce and poles would be stolen. The Arabs cut the wire guys, steal the insulator cups and like to show their marksmanship by shooting the white porcelain line insulators. Cables have been laid through the tunnels by the British engineers to eliminate the difficulties of maintaining the wire line across the mountains on account of wind and snowstorms.

Twelve tunnels 120 to 12,444 ft. long, aggregating 7.3 miles, occur in a distance of 8.4 miles on the Taurus section, the longest opening between tunnels being 570 ft. Originally a single tunnel 6.8 miles long was proposed, with only one curve. To expedite construction, however, a location was adopted following the wild gorge of the Chakit River, thus giving a number of tunnels and consequently a greater number of headings. Concrete arch bridges over the lateral ravines were built in advance of the tunnels, materials being handled over a 13-ft. highway built across the mountains for twelve miles, having zig-zags on the sides of the gorges and numerous small tunnels and temporary bridges. From this road materials were lowered to the railway works on rack-rail inclines.

Bottom headings 6 x 5½ ft. were driven at an average rate of 328 ft. per month in the limestone rock. These were enlarged later for a portable railway, which served to handle traffic temporarily between the standard gage sections, supplementing the motor truck traffic on the temporary highway. The description indicates the use of light air drills held by the men, and some American rock drills were abandoned on account of the time consumed in taking them down and replacing them at each blast. Holes 39 to 60 in. deep were fired by hand in rounds of 20 to 25 holes. Compressed air was used to blow out the gases, but the men could not resume work for about twenty minutes after the blast. Power for all the tunnels was supplied from one plant, a second plant being built as a reserve. The miners were mainly Croats, Italians, Austrians and Greeks, with Russian prisoners for unskilled labor.

These tunnels were completed for standard-gage operation in October, 1918, a month before the armistice. They are of horseshoe section, generally with

12 to 14-in. concrete lining for the arch alone, or for the arch and sides, and having a drain at one side. In loose rock a heavier lining and concave invert were used, with a central drain of masonry on the invert. Notwithstanding the great difficulties of the survey work and the fact that nearly all the tunnels were on curves the lines and levels are reported to have been carried very accurately.

In the Amanus range there are fourteen tunnels 220 to 16,086 ft. long, aggregating 30,196 ft., in a distance of twenty miles. Six years were required in building the Bagtche tunnel, 3.1 miles, as it was driven only from the ends, the great depth of 2,000 ft. below the surface making intermediate shafts impracticable. At one point a stratum of porphyry was encountered and reduced progress to 4 in. per day, but fortunately it proved to be only about 6½ ft. thick. Outside of the two mountain ranges there are twenty-seven tunnels but these aggregate only 9,384 ft.

Of the steel bridges, the largest is that over the Euphrates at Jerablus, having ten through truss spans of 262 ft. It was completed during the war, taking the place of a timber structure, but it is said to have been partly destroyed in 1920 by the Turkish insurgents under Kemal Pasha. The Seihun bridge near Adana has four through spans of 177 ft. and one of 295 ft. The Djihan bridge has four through spans of 164 ft. These two bridges were completed in 1912 and all three have stone piers on pile foundations surrounded by cofferdams. A steel viaduct of the American type crosses the Here Dere gorge, with three deck spans of 243 ft. on two steel towers 50 ft. wide and one masonry pier. At one end is a girder span of 44 ft. and at the other end a truss span of 132 ft. The rails are about 280 ft. above the stream.

A notable stone arch structure is the Giaour Dere viaduct, 705 ft. long and 227 ft. high. The central portion has three 98-ft. arches, with spandrel arches over the piers, and is flanked on each side by four arch spans of 20 to 40 ft. The timber centering was supported on steel I-beams built into the masonry. Material was handled by a cableway. Concrete arch bridges with main spans of 98 ft., carrying spandrel arches, were used in crossing the gorges between tunnels on the Taurus section.

Connections and Operation

The Bagdad Railway from Konia to Bagdad will be about 1,065 miles long. Adding the 500 miles to Scutari and 500 miles to Koweit, the total length will be about 2,100 miles, or 2,000 miles from Smyrna. About 700 miles have yet to be built. Its equipment comprises approximately 90 locomotives, 90 passenger cars, and 1,520 four-wheel box, gondola and flat cars, mainly of 15 tons capacity. Since the armistice, the railway company, now under French control, has been operating some sections of the line, and where the country is under cultivation there is likely to be considerable local traffic. Apart from its political and military purposes, however, Major Heslop considers that the prospects of the railway are very discouraging, owing to the heavy grades, the long stretches of unproductive country, the poor harbor conditions at some of the Mediterranean ports, and the time required to close the 200-mile gap and build the southern extension.

The Aleppo branch of the Bagdad Railway connects with a French line to Damascus, 260 miles, having branches to the ports of Tripoli and Beyrout. From Damascus there is the meter-gage Hedjaz Railway to Medina (800 miles) and Mecca (1,000 miles) built by the Turkish government for military purposes and to carry the immense Mohammedan pilgrim traffic to Mecca. From this line there is a 104-mile branch to the port of Haifa. During the war, the British forces advancing from Egypt built a standard-gage line from the Egyptian Railways at Kantara, on the Suez canal, north to Haifa, 255 miles. This has connections with Acre, Jerusalem and Jaffa. Thus a standard-gage route from Constantinople to Egypt requires only a 108-mile link through rather rough country between Damascus (or Rayak) and Haifa.

Management—The main offices and the headquarters of the operating and maintenance departments of the Bagdad Railway are at Aleppo, but the construction department has its offices at Constantinople. Since the armistice the head or director has been Mr. Schwender, a Swiss lawyer; the chief engineer of construction, Mr. Mavrogodato, is a Greek, and the chief engineer of maintenance, Mr. Wolf, is a Swiss. The assistant engineers are of various nationalities, but were mainly Germans and Swiss under the original management. From Konia to Nissibin the line is under four district engineers, who have American track velocipedes for inspection trips. They go over their districts twice a month and report twice a year on every bridge and tunnel. Employees under the heads of departments include Europeans of nearly every nation, but the laborers and workmen are largely Arabs, Turks, Armenians and Kurds.

After the armistice in November, 1918, the British government took possession of the Bagdad Railway and carried on some construction work. In October, 1919, the French were given occupation of the country, and the line was turned over to them, but at the time Major Heslop wrote it was not known whether the French Government would provide funds to carry on the work.

Qualities of Sand-Lime Brick

Sand-lime brick, according to Circular 109 of the U. S. Bureau of Standards, is a building brick made of sand and lime. It was first produced in the United States in 1901. By the action of steam under pressure the lime is caused to combine with some of the sand, forming a hydrated calcium silicate. This material acts as a bonding agent to hold the rest of the sand together. Most sand-lime bricks will compare favorably with "first common" clay bricks. They are characterized by their straight edges, parallel faces, and nearly white color. Their continued use in northern climates has established their durability under weather conditions, but sand-lime brick is not a refractory material. The industry maintains a national association with which the Bureau co-operates in conducting research work on the subject. Bureau of Standards Technologic Paper 85 contains detailed descriptions of the method of manufacture and of several factories. A good sand-lime brick for general purposes should have an absorption of not over 20 per cent, an average compressive strength of not less than 2,000 lb. per square inch, and an average modulus of rupture of not less than 450 lb. per square inch.

Enlarged Waterloo Station, London and Southwestern Ry.

Largest Passenger Station in England—Steam Main Line and Electric Suburban Trains—Steel and Glass Trainshed Roof—Station Facilities

WITH THE ENLARGEMENT and reconstruction of the Waterloo Station of the London & Southwestern Ry. at London it becomes the largest passenger terminal station in England. With the improvements now approaching completion it will have twenty-one platform tracks for a daily traffic of about 1,200 main-line and suburban trains. Electric operation by the third-rail system is used for the suburban service, which represents about 80 per cent of the total traffic of the station. A curved layout and an eight-track approach are notable points in the station plan, while

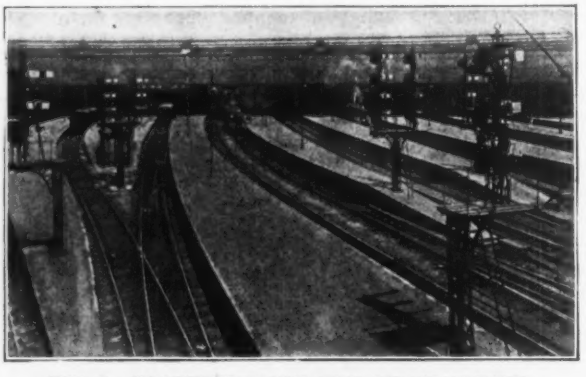


FIG. 1. PLATFORMS AND END OF TRAINSHED

the trainshed roof is of a type little known in this country.

The Waterloo Station, with only three platforms, was built originally in 1848, but extensions were commenced in 1860 and were followed by successive enlargements and alterations to meet the requirements of increasing traffic. By 1900 these piecemeal changes had resulted in such an awkward arrangement that a project was started for the comprehensive improvement and reconstruction of the entire station as a unit. Preparation of the plans and of a construction program which would avoid undue interference with traffic consumed some time. Progress was slow under the difficult conditions and then the work was interrupted by the World War. But it is now expected to have the improvements completed by the end of 1921. A general plan of the station is shown in Fig. 3.

With the purchase of nearly ten acres of land for enlargements the railway company was under the legal responsibility of providing accommodation for residents and institutions displaced. A housing project for 2,000 persons has been carried out, and new churches and schools have had to be built at other locations.

Topographic conditions locate the main entrance at the northwest corner, on York Road, but an additional approach has now been made from Westminster Bridge Road, at the south end. The station floor is above the street level and is carried on brick arches. But since these did not provide sufficient headroom for the new driveway it was necessary to replace some of the arches by a girder framing supported on columns and piers. In some cases the new foundations had to be carried down nearly 30 ft. through peat and gravel to the firm London clay. The ground slopes down from the west side, so that at the northeast corner a bridge extends from the enclosed entrance yard to a neighboring station on the Southeastern & Chatham Ry., as shown. Formerly there was a curved junction track connecting the two railways. It was rarely used but served for transferring special cars. The new improvements have necessitated the removal of this track. A third street approach is provided at the northeast corner by an inclined roadway having a grade of 4 per cent.

Track Plan and Approach—In general the track layout is fan shaped, with most of the tracks on curves ranging from 660 ft. radius for tracks Nos. 12 and 13 to 3,300 ft. for No. 2. The tracks are in pairs, between high platforms, those of each pair being spaced 11 ft. 8½ in. c. to c. They are arranged practically in three groups, two of the groups being separated by a line of offices and the others separated by a broad platform with the distinctively English feature of a carriageway parallel and level with the platform. At the end of this platform are two short tracks for loading and unloading automobiles and carriages. On the west side of the station is a group of tracks for cars and trains held in reserve, together with a small coaling station and a turntable. No special tracks are provided for mail cars.

Third-rail electric suburban trains are handled mainly on tracks Nos. 1 to 4 and 16 to 21. Electric equipment is applied also to Nos. 6 and 7, which tracks can be used either for suburban or main-line traffic. Track construction is of the British type, with bull-headed rails of 90 to 100 lb. per yard carried in cast-iron chairs on wood ties in stone ballast. As the station is at the end of a descending grade, each track is fitted with a pair of hydraulic buffers designed to stop with-

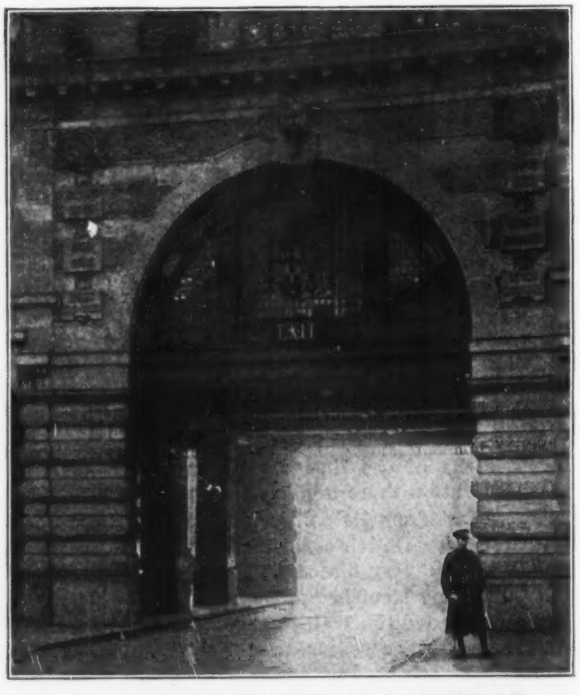
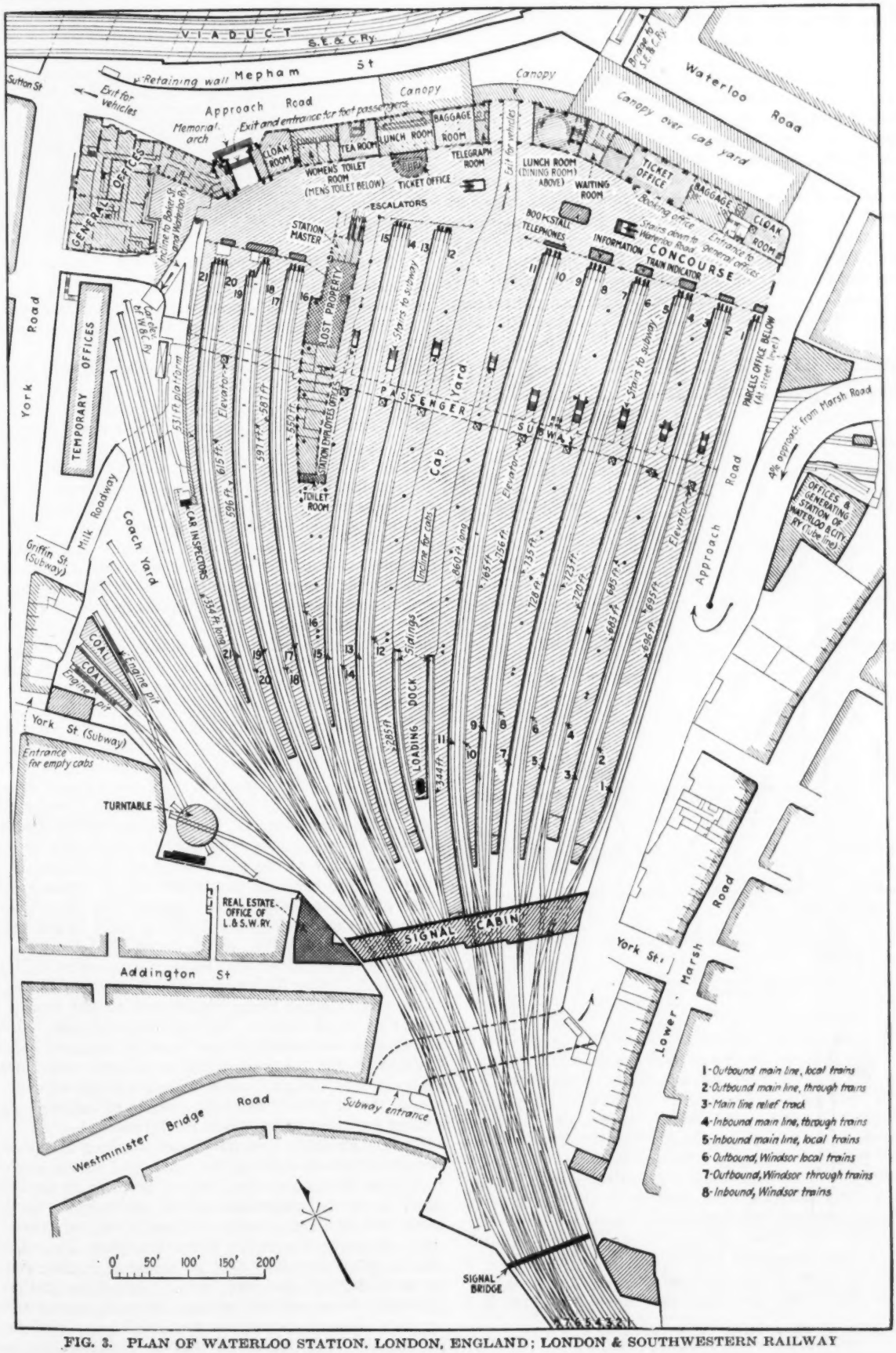


FIG. 2. CARRIAGE EXIT FROM TRAINSHED OF WATERLOO STATION


VIADUCT
S.E.&C.Ry.
Retaining wall
Mepham St
Sutton St
Exit for vehicles
Approach Road
Memorial arch
Exit and entrance for foot passengers
Canopy
Canopy
Canopy over cab yard
Waterloo Road
GENERAL OFFICES
CLOAK ROOM
TEA ROOM
LUNCH ROOM
BAGGAGE ROOM
WOMENS TOILET ROOM (MENS TOILET BELOW)
TELEGRAPH ROOM
TICKET OFFICE
Exit for vehicles
LUNCH ROOM (DINING ROOM) ABOVE
WAITING ROOM
TICKET OFFICE
BAGGAGE
CLOAK ROOM
Booking office
Entrance to Waterloo Road
Stairs down to Waterloo Road
Entrance to General offices
ESCALATORS
STATION MASTER
BOOKSTALL
TELEPHONES
INFORMATION
CONCOURSE
TRAIN INDICATOR
York Road
TEMPORARY OFFICES
Garden of W.B.Ry.
531 ft. platform
LOST PROPERTY
Stairs to subway
Elevator
PASSENGER
SUBWAY
Stairs to subway
PARCELS OFFICE BELOW (At street level)
4% approach from Marsh Road
Cab Yard
Elevator
Elevator
Elevator

out injury a 400-ton train moving at 10 m.p.h. These buffers are used extensively at English railway terminals.

An eight-track approach is one of the special features from an operating point of view, as with such a liberal proportion of approach tracks to station tracks there is avoided the bottle-neck condition which hampers or throttles movements at many large stations. Five of the approach tracks are for main-line service, one of these being a relief track serving inbound and outbound traffic during the morning and evening rush hours respectively. The other tracks are for the Windsor division, two being for through and local outbound trains and the third for all inbound trains. Only a few slip switches are used, although the tracks are thoroughly interconnected. The approach is a long masonry viaduct with arch spans, streets being crossed by steel girder bridges.

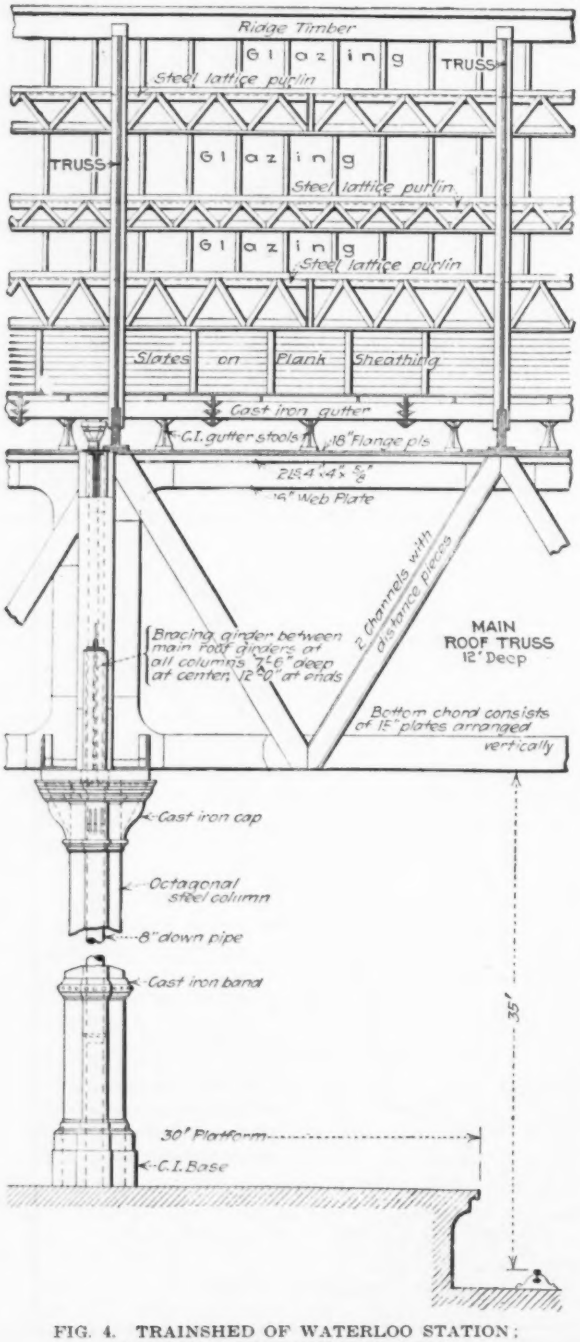


FIG. 4. TRAINSHED OF WATERLOO STATION; LONDON & SOUTHWESTERN RY.

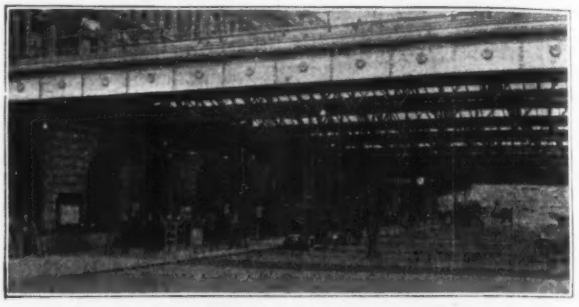


FIG. 5. COVERED PORTION OF CAB ENTRANCE

Platforms and Baggage Handling—Platforms having average and maximum widths of 25 and 40 ft. extend between the pairs of tracks, these platforms being level with the floors of the cars. The longest platforms are Nos. 11 and 13, 860 ft. and 838 ft. respectively, the lengths reducing gradually to 695 ft. for No. 1 and 531 ft. for No. 21. They are of reinforced concrete on steel framing, with asphalt surface and 4-in. stone coping. Asphalt is used also for the broad concourse across the inner ends of the platforms. Fig. 1 shows the outer ends of the platforms, with signal equipment and the glass screen across the end of the trainshed.

A passenger subway across the main part of the station has stairways to the platforms and gives access also to stations on two of the underground rapid-transit "tube" lines. The concourse has stairways to the lower street level and has also ramps and escalators connecting with the underground rapid-transit stations.

The interior longitudinal driveway mentioned above enables incoming passengers from trains on two tracks to go directly to cabs or carriages, these tracks being used principally for important main-line trains. Access to the driveway is by means of an incline from a subway at the street level at the south end of the station, all vehicles passing out through an archway to the yard and street at the north front of the station, Fig. 2. Cabs land outgoing passengers at two covered portions of the station yard, one in front of the baggage room and the other in front of the main ticket office, as shown in Fig. 5.

It may be explained that railway passengers in England usually bring their trunks and heavy baggage with them, the baggage being transferred to and from the trains by hand trucks. For the parcel traffic, which corresponds somewhat to our express business but is handled by the railways, there is a large room under the east side of the station, with a subway extending across the station (under the passenger subway) and having elevators to the train platforms.

Station Facilities and Headhouse—A long three- and four-story building along the north end of the station forms the headhouse, with station facilities on the first floor, along the outer side of the concourse. In the accommodation for passengers there is marked contrast with American practice. From the plan, Fig. 3, it will be noted especially that no spacious waiting room or main hall is provided, as in American stations, but that there are two groups of small rooms with separate accommodation for first-class and third-class passengers. The reason is that in England the sta-

tion serves mainly as a passage to and from the trains, and is not regarded by the public or the railway officials as a general meeting and resting place. In this respect English stations seem uninviting and inhospitable to American travelers.

A handsome stone front forms the street side of the building, the interior construction being of steel and brick. At the northwest corner are located the general offices of the railway. A memorial arch in honor of the railway company's employees who lost

Roof construction for the trainshed, Fig. 4 and 6, is of a so-called "ridge-and-furrow" type which is little known in this country but is used extensively in England for roofs of large area. Lines of parallel chord trusses of 80 to 130 ft. span extend across the station at intervals of 60 ft. and upon these rest 60-ft. triangular trusses 15 ft. high, which are spaced 15 ft. c. to c. Across the latter trusses are laid latticed purlins, brackets which carry plank walks or gangways. Advantages claimed for this type of roof are

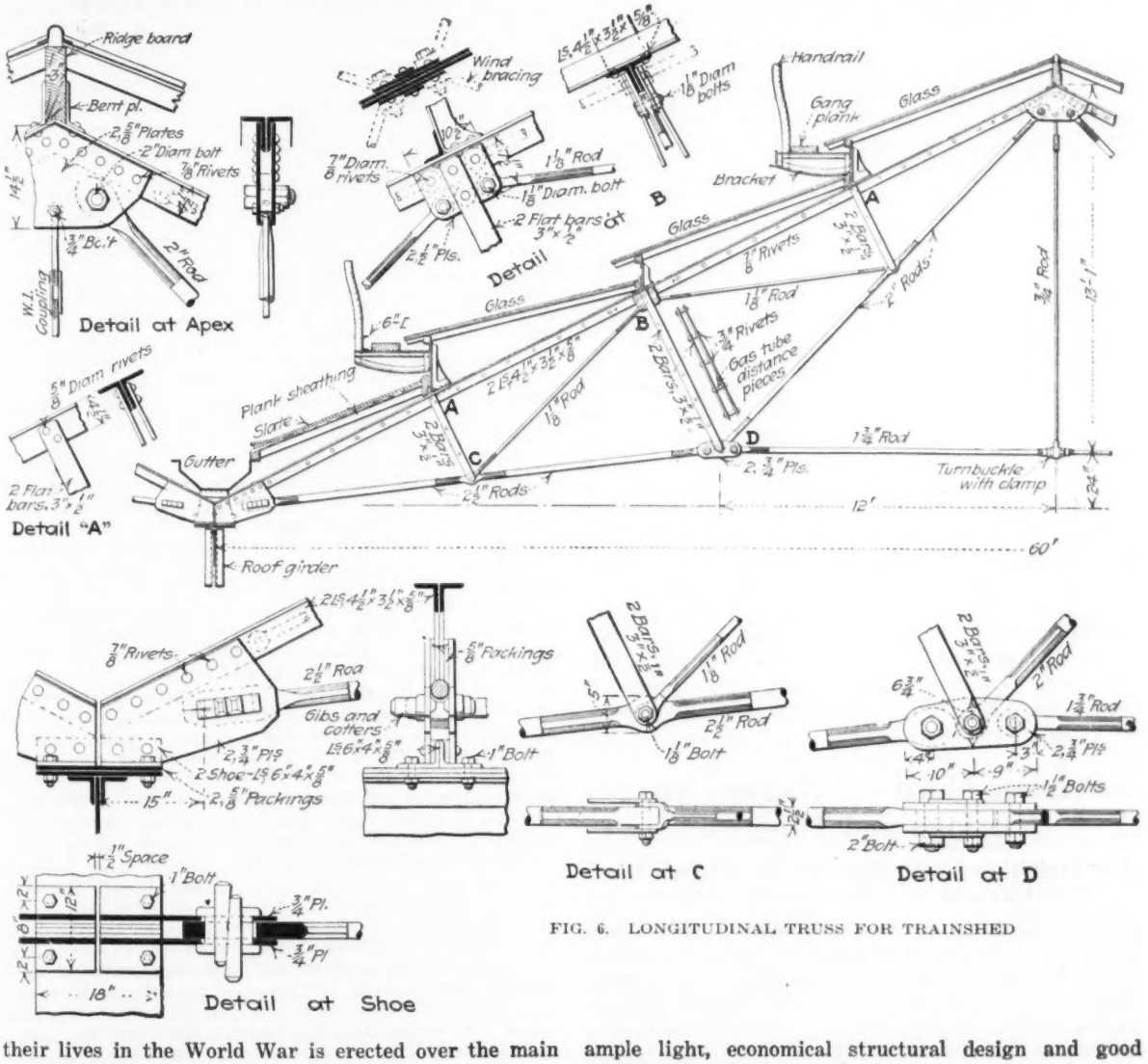


FIG. 6. LONGITUDINAL TRUSS FOR TRAINSHED

their lives in the World War is erected over the main entrance and exit for foot passengers.

Trainshed—A steel-frame roof covered mainly with glass forms the trainshed, ample provision for ventilation being made in the roofing. Columns are located on the platforms in the main part of the building, including tracks 1 to 16, but for the remainder of the west side of the station the columns are in the spaces between the tracks, with a headroom of about 25 ft. above the rails. In the former part there is a clear headroom of 35 ft. above rail level, giving about 22 ft. above the smokestacks of the locomotives. It is reported that the purpose of this lofty trainshed is to permit of a possible future double-deck construction.

ample light, economical structural design and good facilities for cleaning and repair.

The triangular truss design, with its key and bolt connections, Fig. 6, is of interest to structural engineers in this country. The ends of the tie rod are secured to the connection plates by grooved gibs and a pair of taper keys or cotters driven in opposite directions. At the middle is a turnbuckle around which is a clamp bent to form ears for the attachment of the bolt of the vertical rod. Each strut is composed of a pair of flat bars with spacing sleeves between them and rivets through the sleeves, the upper ends of the bars being riveted to the top chord and the lower ends having a pin or bolt joint with the rod members.

Steel is used for the top chords, struts and connection plates. Rods and bolts are of wrought iron, turned bolts in drilled holes being used for the connections. The wind bracing between the trusses consists of 1¼-in. rods with ⅞-in. bolts.

Rolled plate glass constitutes almost the entire covering, slate on plank sheathing being used only for the lowest panel of each ridge, adjacent to the cast-iron gutter which forms the bottom of the "furrow." The glazing is arranged in steps, as shown, with ventilator openings between them. Notwithstanding the great area of roof, there is said to be little trouble from breakage of glass due to expansion or vibration movement in the steel framing. A glass screen closes the end of the trainshed to within about 15 ft. above the rails, Fig. 1.

TRAFFIC AT WATERLOO STATION IN 24 HOURS, 1921

	Loaded Trains	Empty Trains
Main line, inbound	73	37
Main line, outbound	68	41
Suburban, inbound	454	25
Suburban, outbound	452	27
Total	1,047	130
Total loaded and empty trains	1,177	.....
Maximum inbound in rush hour, 9-10 a.m.	40	.....
Maximum outbound in rush hour, 5-6 p.m.	41	1
Per cent of suburban trains (electric)	80.6	38.4

Traffic Conditions—Regular traffic of this station for a 24-hour period averages 1,177 trains, of which 130 are empty. In addition there are numerous engine and switching movements. A signal cabin just beyond the station extends across the entire width of the tracks, and beyond this again is a signal bridge spanning the tracks. Signals are erected also at the ends of the platforms, Fig. 1. Suburban trains operated by electricity constitute over 80 per cent of the traffic. These conditions are shown by the accompanying table.

Engineers—The general scheme of reconstruction was planned under the direction of the late J. W. Jacomb-Hood, chief engineer. It is being carried out by A. W. Szlumper, the present chief engineer of the London & Southwestern Ry., with R. D. Hawes as assistant engineer in charge of construction.

Relative Merits of Hudson River Bridge and Tunnels

For Freight and Passenger Service Between New York City and New Jersey—Cost Analysis

CRITICISM of the "automatic-electric" system proposed in the report of the New York, New Jersey Port & Harbor Development Commission, as its ultimate solution for primary distribution and collection of Manhattan freight, is contained in a statement by Gustav Lindenthal, issued Feb. 25, 1921, comparing this system to the double-deck freight and passenger bridge that Mr. Lindenthal has proposed be built across the Hudson River connecting New York City with New Jersey. Mr. Lindenthal's proposal, together with a detailed outline of the traffic capacities of such a bridge, were presented at the annual meeting of the American Society of Mechanical Engineers, Dec. 9, 1920 (see *Engineering News-Record*, Dec. 23, 1920, p. 1246). The principal criticism of the commission's plan, embodied in his current statement, is that it fails to provide for passenger traffic and the handling of heavy bulk materials and low-grade tonnage including coal. An abstract of Mr. Lindenthal's statement follows:

Following the report of the commission the impression has been created that a bridge across the Hudson River in connection with a marginal elevated railroad on the west side of Manhattan would be uneconomical. In a comparative analysis it should be considered that the commission's plan provides for freight only; does not provide for coal and other bulk freight; it is of local benefit to lower Manhattan only; its economy is not inherent in the type of construction but in system of operation; it does not provide rail connection with steamship piers on Manhattan; as a system it is untried on a large scale; its great cost is not justified by probable benefits. On the other hand, the bridge plan would be cheaper than tunnel operation on basis of similar service, and its capacity for freight would be much greater than the automatic-electric system. It would provide not only for bringing heavy and bulk freight in standard cars into New York City, but also for carrying 300,000,000 suburban passengers and 30,000,000 vehicles across the river annually. A large union station for the long distance trains of all railroads from both states centering in New York would also be provided.

The commission's report deals only with freight transportation and estimates the cost of the first half of the underground automatic electric system at $201,190,000. On the same basis of comparison and taking the commission's estimates, so far as they are applicable, the bridge and marginal elevated railroad plan would cost only $175,000,000, or $26,000,000 less than the tunnel plan. On this estimate the portion of the bridge and elevated structure which would serve the automatic-electric freight operation has been liberally estimated at $45,000,000. The problem of passenger transportation cannot be solved comprehensively and economically by detaching it from the problem of freight transportation.

The automatic-electric system would carry principally food and general merchandise, which must be transferred to small cars. Coal, heavy structural material, machinery and similar bulk freight would mostly have to be transported to Manhattan as heretofore by expensive lighterage or car floats subject to delays and tie-ups that have caused hardship. The bridge plan is not limited to any kind or portion of freight. Particularly it can handle coal promptly to storage bins on the entire length of Manhattan Island. It will be able to accommodate the transportation of all kinds of freight at the rate of 60,000,000 tons per annum, looking to the future, whereas the capacity of the tunnel system proposed by the commission is limited, under best assumptions, to 15,000,000 tons per annum, which capacity may be reached in a few years. The bridge plan would also provide for direct carload interchange between New Jersey railroads and those on the other side of the river.

It can be shown that not only a part but all freight (if necessary, also coal and other bulk freight) can be transported in motor trucks from the proposed large railroad receiving and classification yard in the Jersey Meadows over the bridge to any part of Manhattan for store delivery from the Battery to Spuyten Duyvil, or across the East River bridges (or vice versa), *and with only two handlings* (one for loading, another for unloading), *cheaper and speedier than through the proposed tunnel system*, which has a limit of 50,000 tons *per day*, as indicated in the report. As against this the roadway alone over the bridge with fourteen lanes of vehicle travel will have a capacity of *10,000 tons per hour* without interfering with fast vehicles for passenger traffic. All this makes possible a volume and elasticity of operation absent in the proposed tunnel system.

For a Standard Form of Contract

Following the suggestion made before the American Water Works Association last year by G. W. Buchholz of the General Contractors' Association, the American Water Works Association has appointed a committee to co-operate with the General Contractors' Association in an attempt to draw up a standard form of engineering contract. The chairman of the Water Works Association committee is J. Waldo Smith, of New York

A Review of Column Formulas for Bridge Design

An Argument for Returning to the Rankine Formula—Plotted Tests to Failure Establish Its Correctness —Other Formulas Wasteful Because Approximate

By an Engineer of Bridges

SOME tests on small-sized wooden compression members recently published by the Bureau of Standards give a new illustration of a fact that has been demonstrated time and again in the past, namely, that the strength of struts is correctly portrayed by a formula of the Rankine type. In spite of modern preferences for other formulas, in the design of steel columns particularly, every series of tests forcibly directs our attention to the older formula. If this gives truer proportioning of compression members than, for instance, the straight-line formula, it seems an inescapable conclusion that the latter will produce sometimes weaker columns and sometimes less efficient columns—wasteful of metal—and therefore must result in unscientific designing. Would it not be wiser to return to the use of the Rankine formula?

Doubtless the method by which Professor Rankine derived his formula is known to all structural engineers; it will not be restated here. Tests to verify a column formula may be made either with round (theoretically

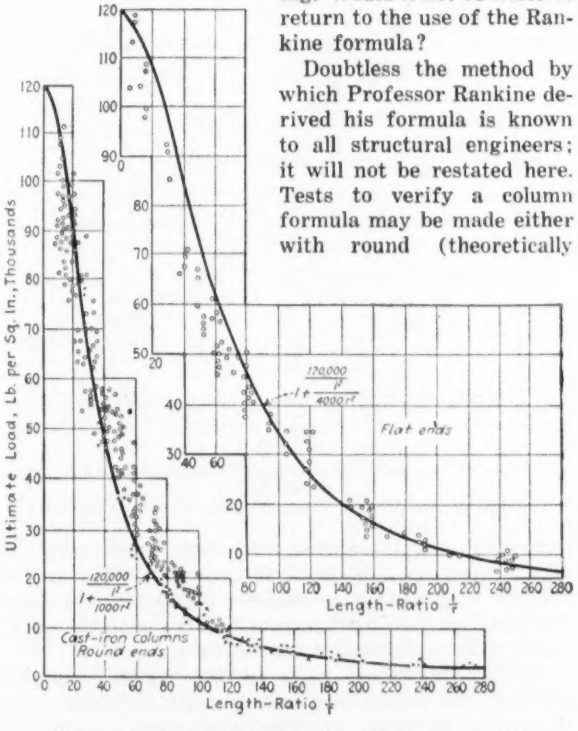


FIG. 1. CAST-IRON COLUMNS, ROUND END AND FLAT END
(Tests by Tetmajer and Hodgkinson)

hinged) ends or flat (fixed) ends, since the two conditions bear a definite mathematical relation to each other. The points of inflection of the bent column with fixed ends are (in strict theory) at the quarter points of the column, and therefore the middle half length will form in effect a column whose ends are of a freedom comparable to that at a hinged end. Then the constant in the formula must be four times as large for hinged ends as for fixed ends; since its value for fixed ends in tests of wrought-iron columns has been found to be 1/36,000 its hinged-end value is 1/9,000. The same values apply to steel, as its modulus of elasticity is the same. Thus we have the following formulas:

$$p = \frac{S}{1 + \frac{l^2}{36{,}000\, r^2}} \quad \text{for fixed ends}$$

$$p = \frac{S}{1 + \frac{l^2}{9{,}000\, r^2}} \quad \text{for hinged ends}$$

Experiments by Tetmajer, Hodgkinson and others on cast-iron specimen columns, summarized in the two plots in Fig. 1, supplied remarkable confirmation of this formula. Half a century later the recent Bureau of

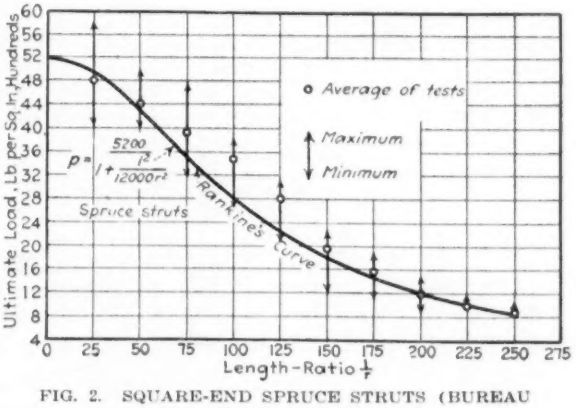


FIG. 2. SQUARE-END SPRUCE STRUTS (BUREAU OF STANDARDS)

Standards test on spruce struts for airplane work, Fig. 2, give equally gratifying confirmation. Clearly, Rankine with his theory outlined the true law of flexural failure of columns. It is to be expected that full-sized tests, involving the effect of imperfections of manufacture and variation of material, will give less uniform results, but this should not disturb our conception of the fundamental law of column failure.

Later the straight-line formula for column strength was proposed, and in bridge design the formula 16,000 — 70 l/r came into use, as approximating the Rankine hinged-end formula in its results (the formula for fixed ends had by this time fallen into disuse, on the view that all bridge compression members are in a state of flexure requiring the use of the hinged-end formula). It developed that the straight-line formula allowed higher stresses to be used in the usual range of column length, or for values of l/r between 50 and 180; on the other hand, for higher values than 180 it would produce very much heavier columns. The writer has always believed that it is this fact which led to the limitation of column length in specifications. The general claim is that "longer columns would be unsafe," yet it will be seen on comparing the straight-line formula with test results or with the Rankine formula that under the former long columns are *ultra-safe*. It is also worth notice that for lengths over 230 the straight-line formula allows no stress whatever; in other words, it makes such columns impossible regard-

less of arbitrary length limitations, although we know that such columns do have some strength, however small.

What do tests on full-sized columns show? As already remarked, the unavoidable variations in material and manufacture would be expected to produce less consistent results. Yet all full-sized tests uphold the Rankine formula, as will be seen.

Fig. 3 shows tests of 5-in. steel tubing at Watertown Arsenal in 1908. Both flat and clamped ends are included; evidently there is no practical difference between the two. Comparing the plotted points with the Rankine formula curve also drawn, it is seen that the longer columns made a slightly better showing than those of shorter lengths, which again throws doubt on any arbitrary limitation of column length. Even though compression members in actual bridges are usually

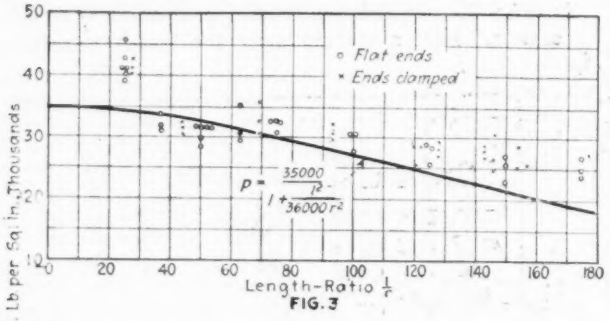


FIG. 3

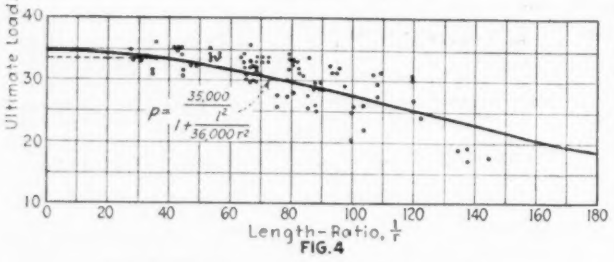


FIG. 4

FIG. 3. TESTS OF 5-INCH STEEL TUBES
(Flat and clamped ends shown to be equivalent. Tests made at Watertown Arsenal, 1908)

FIG. 4. BUILT WROUGHT-IRON COLUMNS, PIN ENDS
(Single and double channel, box and I-sections. Watertown Arsenal, 1881-84)

short we should nevertheless recognize the existing strength of long columns and should not condemn structures in which such long columns are found. In one steel trestle, for example, there is a long column, too long to fit the straight-line formula, which was trussed by light rods after the structure had been in existence some time to give it an appearance of strength; the trussing is of little value in making the column stronger, and in place of giving the structure an appearance of strength it really serves to call attention to the column and make it appear weak. The column is of ample strength for its purpose, and should be credited with its actual capacity.

Further evidence that long columns have a very definite strength is furnished by tests on iron compression members of various sections made at Watertown between 1881 and 1884, as plotted in Fig. 4; and in the tests of Christie, Bouscaren and others plotted in Fig. 5. The behavior of steel is quite the same, as shown by some Watertown tests of 1909, recorded in Fig. 6. While the latter tests were made with pin ends, there is every evidence in the results that the pins, under load, did not act as hinges but fixed the ends; compare Fig. The constant 1/36000 applies to all the tests ju referred to. Other data of the same kind are given b test of Phoenix and Z-bar sections, Fig. 8.

We now come to the tests made under direction o the committee on steel columns of the American Societ of Civil Engineers, probably the most complete an systematic of any yet made. While the subject is no directly to the point here the writer cannot refrai from mentioning the clear-cut demonstration furnished by these tests that heavy material, which has received less work in rolling in the mill and is therefore softer, is quite apt to weaken a column; no one who has to do with design of structures should fail to keep this demonstration carefully in mind.

The A. S. C. E. tests have been plotted in the left-hand

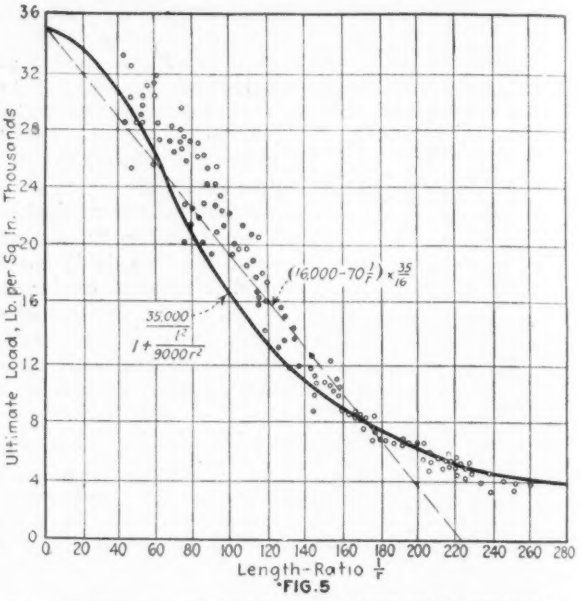


FIG. 5

FIG. 5. BUILT AND ROLLED WROUGHT-IRON COLUMNS, ROUND ENDS
(Tests by Hodgkinson, Tetmajer, Bouscaren and Christie)

part of Fig. 9 to represent fixed-end conditions. To record them on a hinged-end basis the value of half the test length has been used for plotting in the right-hand part of the diagram, in which the confirmation of the Rankine formula is more clearly evident.

All the preceding data, in the writer's opinion, establish the Rankine column formula as representing truly the strength of iron and steel compression members, and as the formula which should be used in bridge design. It remains to consider the question of fixed *versus* hinged ends.

In the early days of modern designing it was customary to use both the fixed-end and the hinged-end formula, according to what was considered to be the end condition of the particular column; in fact, formulas applying to a column with one fixed and one hinged end were sometimes used for a member which the designer believed to be in a corresponding physical condition. However, when the danger of secondary stresses arising from the distortion of a structure came to be more clearly recognized the fixed-end formula lost favor; it was concluded that these secondary stresses would be better allowed for if columns were proportioned by the hinged-end formula.

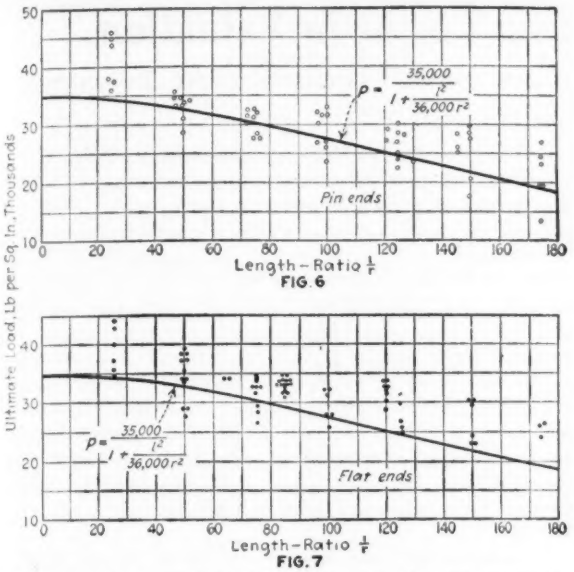


FIG. 6

FIG. 7

FIGS. 6 AND 7. STEEL COLUMNS, PIN AND FLAT ENDS (Built and rolled I-sections, channels and tubes. Watertown Arsenal, 1909. No difference between pin-end and flat-end tests)

Free ends of columns do not exist in structures, however. It seems that more attention is being given to this fact in recent years than to the undeniable existence of secondary stresses affecting columns. At any rate the conservative practice of using the hinged-end formula is being abandoned, it would appear, for numerous proposals are being made that tend toward producing lighter columns. Undoubtedly there is a desire at present to reduce the cost of construction, but it would be an engineering mistake to reason on the assumption that a column formula that will sanction the lightest columns will be the quickest to find acceptance.

The straight-line formula, already light as compared with the Rankine formula, was made still lighter by the A. S. C. E. column committee, which proposed a uniform column load of 12,000 lb. per sq.in. up to a length of 80, thence reducing at the rate of 100 l/r. Quickly following this proposal came that of the American Railway Engineering Association, 15,000 — 50 l/r, with a maximum of 12,500, and this may be succeeded by a still lighter one, 15,000 — 40 l/r. Then for the sake of novelty, perhaps, the formula 12,500 — $\frac{1}{4}$ l^2/r^2 was introduced; and this has again been outdone, and again lighter columns authorized, by the formula 13,000 — $\frac{1}{4}$ l^2/r^2. The whole crop of formulas is empirical and arbitrary. Apparently the race is to the swift. Whither are we drifting?

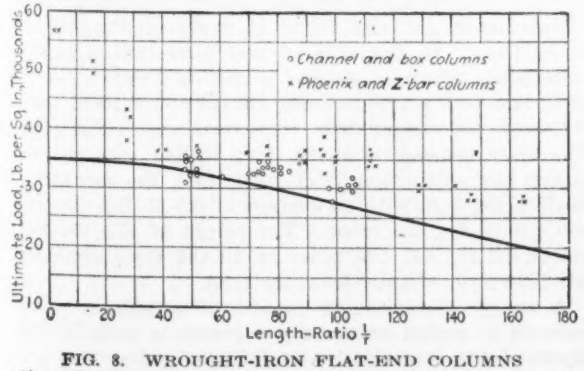


FIG. 8. WROUGHT-IRON FLAT-END COLUMNS (Channel, box, phoenix and Z-bar sections, with some unusually high results)

As a conservative and well digested hinged-end formula, probably that in use by one of our large railroad systems is adapted to the requirements of practice more nearly than any yet proposed. This, with 16,000 as a basal unit stress, becomes

$$p = \frac{16{,}000}{1 + \frac{l^2}{13{,}500\,r^2}}$$

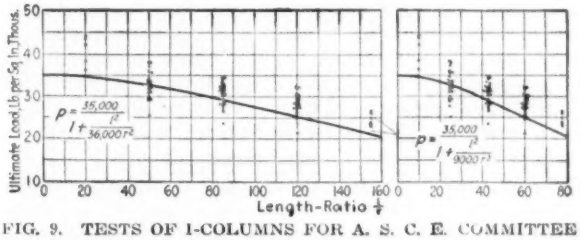


FIG. 9. TESTS OF I-COLUMNS FOR A. S. C. E. COMMITTEE

A plot of this formula together with a number of others is given in Fig. 10, and a condensed list of allowable stresses follows here:

WORKING STRESSES FOR COLUMNS
(In thousand-pound units)

Formula $p = \frac{16}{1 + \frac{l^2}{13{,}500\,r^2}}$

l/r	P	l/r	P	l/r	P
40	14.3	86	10.3	135	6.8
42	14.1	88	10.2	140	6.5
44	14.0	90	10.0	145	6.2
46	13.8	92	9.8	150	6.0
48	13.7	94	9.7	155	5.8
50	13.5	96	9.5	160	5.5
52	13.3	98	9.3	165	5.3
54	13.2	100	9.2	170	5.1
56	13.0	102	9.0	175	4.9
58	12.8	104	8.9	180	4.7
60	12.6	106	8.7	185	4.5
62	12.4	108	8.6	190	4.3
64	12.3	110	8.4	195	4.2
66	12.1	112	8.3	200	4.1
68	11.9	114	8.1	205	3.9
70	11.7	116	8.0	210	3.7
72	11.6	118	7.9	215	3.6
74	11.4	120	7.7	220	3.5
76	11.2	122	7.6	225	3.4
78	11.0	124	7.5	230	3.2
80	10.9	126	7.3	235	3.1
82	10.7	128	7.2	240	3.0
84	10.5	130	7.1	245	2.9

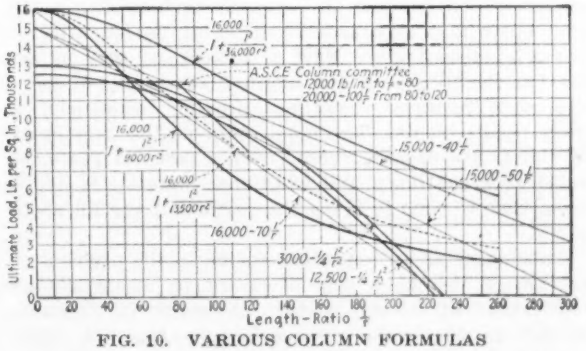

Ultimate Load, Lb. per Sq. In., Thousands
Length–Ratio $\frac{l}{r}$
A.S.C.E. Column committee
12000 lb./in.² to $\frac{l}{r}$ = 80
20,000 – 100 $\frac{l}{r}$ from 80 to 120
15,000 – 40 $\frac{l}{r}$
15,000 – 50 $\frac{l}{r}$
16,000 – 70 $\frac{l}{r}$
3000 – $\frac{1}{4}$ $\frac{l^2}{r^2}$
12,500 – $\frac{1}{4}$ $\frac{l^2}{r^2}$

FIG. 10. VARIOUS COLUMN FORMULAS

It should be remembered that in the case of short columns the allowable stress is limited by the details of design. These details should be proportioned, of course, with regard for their ratio of length to thickness. In good engineering practice the ratio $l/d = 12$ has usually controlled the detailing, and, as this corresponds to $l/r = 40$, the tabular stress for this ratio is the highest allowable loading on any column. The column stress therefore is not subject to whimsical variations.

Subsidence of Earth Fills as a Factor in Valuation

Railway Investigations Indicate Both Firm and Soft Ground Settle Appreciably Under Embankments and Thus Increase Earthwork Quantities

SUBSIDENCE of the ground under railway embankments, due to the load placed upon it, as an important and almost universal factor affecting the quantity of material required both for construction and maintenance of the embankments is shown convincingly by extended investigations which have been made during the past few years by a number of railways in connection with their valuation work. These investigations have been reported to the Engineering Committee of the Railroad Presidents' Conference Committee on federal valuation, but heretofore have not been published. Graphic illustrations of conditions discovered are afforded by the accompanying diagrams selected from the reports. The subject is considered as entirely separate from the question of shrinkage dealt with in another report of the Presidents' Conference Committee (see *Engineering News-Record*, Aug. 26, 1920, p. 418). An abstract of the subsidence investigations as reported to the carriers' engineering committee follows:

Subsidence of swampy ground and resultant loss of fill is a common experience and needs no proof. Abnormal conditions of subsidence and loss at sink holes are also well known. But the point of the matter is that these and other investigations indicate subsidence as practically universal in both firm and soft ground under railway embankments, and consequently are an important factor in estimating earthwork quantities. If this is not fully recognized in valuation work the railways will not receive proper credit for actual cost of the existing works.

Subsidence and Shrinkage

It is evident that subsidence must result in increasing the amount of fill material beyond that estimated for a fill of given height above the original surface of the ground. The extent of subsidence varies with the character of the soil and subsoil but is appreciable even on apparently firm ground, while in soft ground the volume of fill beneath the original surface may equal that above it, thus practically doubling the quantity of the original estimate. Part of this excess may be applied as the fill is built, the original borrow pits or other source of material sometimes proving insufficient to meet requirements. The application of the remainder of the excess may be spread over a term of years, as subsidence continues and additional material is added from time to time to bring the surface of the fill up to grade.

Subsidence as an important factor in the problem of earthwork shrinkage was discussed in an article on "Shrinkage of Loosely Filled Earthwork in Embankments" in *Engineering News-Record*, June 24, 1920, p. 1256. It was shown also that the matter has a wider bearing than its relation to shrinkage, reference being made to a report of the American Railway Engineering Association which stated that investigations on several hundred miles of line indicated that subsidence exists under practically all embankments and should be considered when revaluation surveys are being made.

As to the importance of subsidence in relation to valuation, it will be seen that this behavior of the ground has caused railways to place and pay for a much greater quantity of fill material than that required above the normal or original level of the ground. For instance the report of one Eastern carrier shows that investigation on 85 miles of fill developed 7,287,675 cu.yd. of excess material due to subsidence. Allowing 10 per cent for shrinkage in the distribution of grading this would represent approximately 8,016,443 cu.yd. of material excavated and paid for. Common excavation on this road may be estimated as worth in ledger value, say 35c. or more per cu.yd., so that the excess discovered represents a cut of at least $2,805,755. According to the report the cost of the tests which disclosed this material was only 0.215c. per cubic yard, or in other words $1 of ledger value was produced at a cost of 0.6140.

On another Eastern carrier borings in one fill across a swamp developed the existence of 250,000 cu.yd. of filling material below the normal ground line; similar work elsewhere disclosed about 700,000 cu.yd. of excess or subsurface material, the cost of exploration being only 0.3c. per cubic yard. In 38 tests on one road the depth of subsidence of fills 3½ to 10 ft. high on soft and stiff mud was from 1.2 to 8.5 ft. The aggregate original depth below base of rail for the fills at the points tested was 220.8 ft., but the total subsidence was 164.7 ft. as determined by wash borings and 170.5 ft. by sounding with an iron rod. In other words, the depth of fill below base of rail was increased approximately 75 per cent.

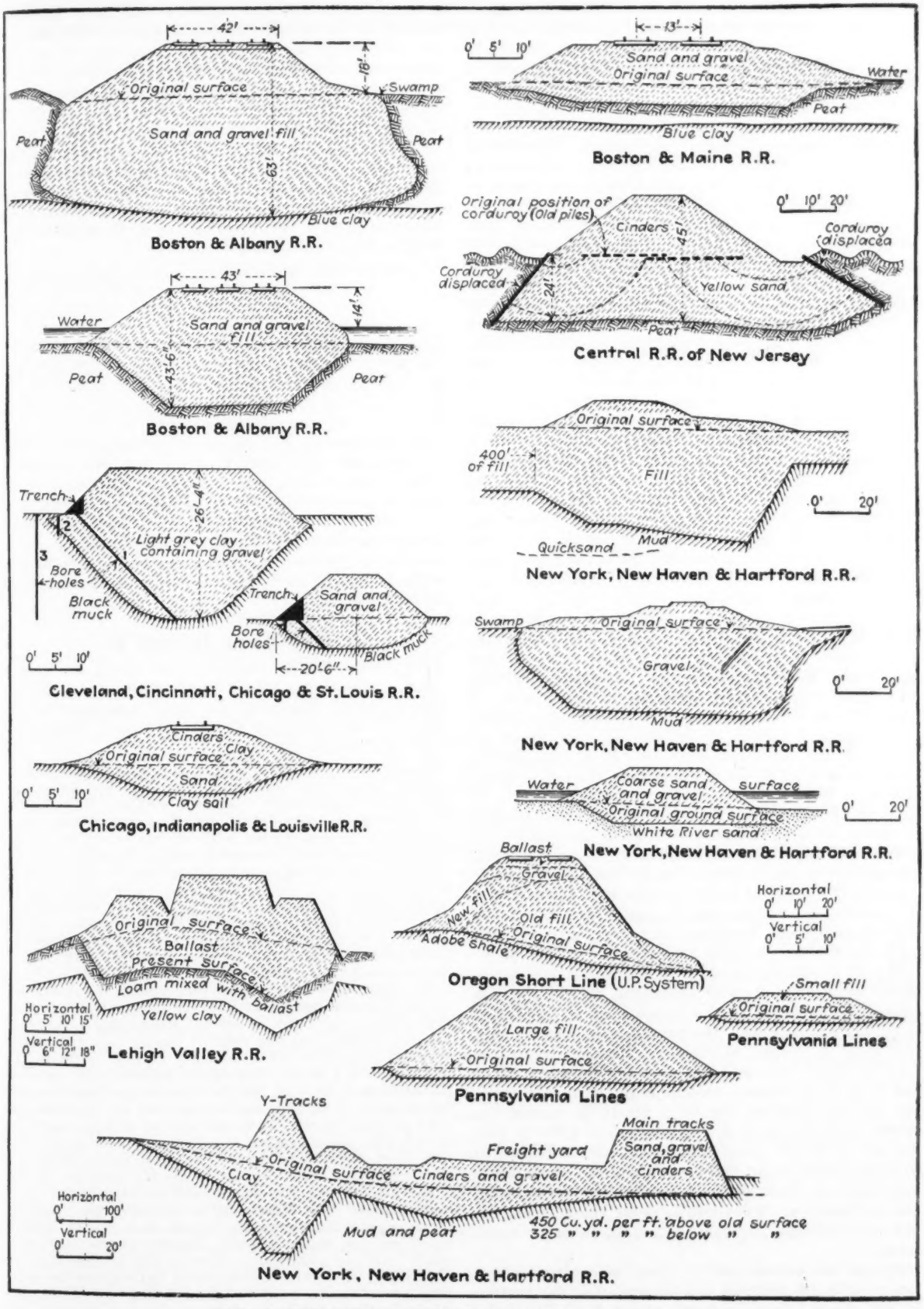
Subsidence at points where there was no fill, the ballast being laid directly upon the soil, was discovered by borings on double track and four-track sections of another carrier. Where the soil was 0.8 ft. of loam over yellow clay both loam and clay had settled to form a depression or channel. In the yellow clay the area above the original surface was 67.50 sq.ft., while the area below that surface was 67.0 sq.ft. In red clay and loose shale the areas above and below the original ground line were 65 and 31 sq.ft. respectively. Tests of fills on mud, peat and marshy ground on another carrier showed that the subsidence or material below the original ground line was from 79 to 432 per cent of the material above that line.

Subsidence Practically Universal

Subsidence was also found at unexpected points on many lines. In the case of two lines investigations were made where in general a shallow sandy loam is underlaid with gravel and clay subsoil and without tests it would not appear that there was any subsidence. The tests showed, however, that it had occurred on almost the entire length of both lines, the maximum depth being 3 ft. with an average of 0.5 ft. for one line and 0.9 ft. for the other. The height of fills did not exceed 12 ft. On 103 miles of fill the tests disclosed 409,246 cu.yd. of subsidence material.

A strong statement in regard to subsidence as a common or almost universal occurrence is made in the report of one investigation as follows:

"Recent investigation of embankments has developed



TYPICAL EXAMPLES OF SUBSIDENCE UNDER RAILWAY FILLS

subsidence quantities of sufficient extent on lines where there was no reason to expect that subsidence would be found to warrant the suggestion that there should be made arbitrary allowances for subsidence per mile of all embankment, dependent on limited tests over similar areas."

The investigation here mentioned was made on two valuation sections, selected at random, aggregating 218.2 miles of road with 150.5 miles of embankment. Excluding 1.9 miles not investigated and 0.4 mile of known sinkhole, there were 148.2 miles of embankment on apparently firm ground, but subsidence of such ground had occurred under 49.8 miles, or 33.6 per cent of the total 148.2 miles. The total subsidence found was equal to 10.7 per cent of the quantities of all embankment investigated, as determined from the cross-sections taken by the Interstate Commerce Commission, and 23.9 per cent of all embankment quantities under which subsidence was found. The average cost of investigation was only 0.46c. per cubic yard of subsidence discovered. In general the top soil was loam on a clay subsoil.

Failure to discover subsidence by tests at certain points is reported by one Eastern and one Western carrier. In the former case isolated tests in two states were made at three gravel fills 2 to 4 ft. high and one 20 ft. high, all on clay soil. Trenches were cut in the fills and the report states that the original surface was readily distinguishable. In conducting the valuation work tests with iron bars were made wherever there was any question as to subsidence. A summary of the results is given in the table.

On one Western carrier no subsidence was found on lines except that through the lagoons in the northwest where the subsidence varied from 40 to 87 per cent of the embankment material. A curious condition was found on this road, however, in the raising of ground level along the fills, thus apparently reducing the height and volume of the fill. On one stretch of 200 miles the measured quantities above the present ground line were 22 per cent less than the record quantities.

In another case material from a 30-ft. embankment sloughed off and raised the adjacent ground so as to cover up 22 per cent of the quantity placed in the fill. The slight subsidence directly under the bank evidently squeezed out material on either side, thus raising what still appeared to be the normal ground surface. In the case of other roads, however, the settlement is confined mainly to the space directly under the base of the fill.

Special conditions met with in building embankments have been mentioned above. However, another striking example is reported in the building of an important cutoff line in the East. The trouble here however, was something more than subsidence. The old line was on a bench cut in the mountain slope on the east side of and 15 to 20 ft. above a swamp at the head of a creek, but the new location was on a fill 40 ft. nearer the swamp and 6 ft. above it. The swamp is 4,700 ft. long and 300 to 400 ft. wide, with black muck soil covered with trees and brush, this growth and the rocky slopes indicating no great depth of muck. The embankment was estimated at 30,000 cu.yd. above the surface, but this was increased to 90,000 cu.yd. to allow for subsidence.

Filling was commenced in June, but at the end of two months all material had disappeared, the surface of the swamp rising in some places 6 ft. above the subgrade level. A new location was then adopted excavating the old roadbed for two tracks and placing the other tracks on a fill alongside the swamp. Frequent slides occurred without warning and sometimes the bank and construction track would disappear during the night. Six sink holes were encountered, requiring from 7,128 to 101,172 cu.yd. each or a total of 216,820 cu.yd. At the largest hole, 86,000 cu.yd. were dumped in the length of the contractor's train before the fill began to show above the surface. Dumping caused the surface of the swamp to rise and fall in waves for a distance of 200 ft., indicating that probably the 40 ft. of muck was floating on an underground lake.

SUBSIDENCE IN 148 MILES OF EMBANKMENTS ON FIRM GROUND OF AN EASTERN CARRIER

Ave. Height of Fill to Subgrade, Ft.	Volume of Fill (I. C. C. Quantities) Total Investigated, Cu.Yd.	Volume of Fill (I. C. C. Quantities) Where Subsidence Was Found, Cu.Yd.	Subsidence Quantity, Cu.Yd.	Per Cent Increase of Fill Due to Subsidence Of Quantity Investigated	Per Cent Increase of Fill Due to Subsidence Of Quantity Where Subsidence Was Found
Up to 10 ft.	3,766,303	1,422,510	409,740	10.9	28.8
10 to 20 ft.	2,302,754	1,155,805	239,128	10.4	20.7
20 ft. and over	672,320	443,096	74,666	11.1	16.9
Total.....	6,741,377	3,021,411	723,534	10.7	23.9

A two-track fill was completed in September of the following year, with 356,467 cu.yd., but in the next year a 300-ft. length disappeared and had to be made good with an additional 54,360 cu.yd. of material, while a year later it was necessary to drive piles and place stringers for 140 ft. To carry the embankment along the side of this swamp required the placing of 497,834 cu.yd., instead of the 90,000 cu.yd. provided at first as a liberal estimate.

Don't Write It—Say It

"DON'T *write* it—*say* it" is the advice the recent engineering publicity conference of the American Association of Engineers got from Alexander Black, editor of the Newspaper Feature Service of New York City. Further he stated:

The whole trend of good writing is toward colloquial simplicity. As ranting has disappeared from the stage, fine phrases are disappearing from good writing. Some people not only sound *written*—they sound as though they were singing it. In speech they will tell you where they live. In writing they don't live—they reside. They don't *begin*, they *commence*. They never "had a talk." They "held a conversation." In other words, they "take their pen in hand" and the reader gets the ink on him. The average person doesn't write a personal letter as if he were saying something to a friend. He writes a *letter*, and it sounds like a letter. Some men make even an after-dinner speech the same way. They don't *talk*. They *speech*.

My experience with writers on science, on practical things, is not so much that they are too complicated as to their subjects as that they are too complicated as to their English. Simply imagine yourself *saying* it to the policeman and you will be able to keep your feet on the earth. If I can read a thing aloud and it doesn't sound *written*, I know I am on my way. In the average case quick writing will sound more written than writing that has been worked down to clean terms. It isn't a matter of long words or short words. Some long words are very common—commoner than they ought to be. Some beautiful short words are quite unfamiliar. In speaking to the big audience, words it will accept, used in a way it will accept, are the great consideration. The right word is developed by a feeling for *saying* it. To get this feeling one must practice saying it. There are many mistaken theories as to what "the public" will not understand. Most of the disappointments come not from failure to understand, but because the public's natural human interests have not been sufficiently considered and successfully reached.

Methods of Investigating Subsidence Under Railway Fills

WASH and auger borings, core drills, sounding rods, test pits and trenches are included in the methods employed by the railways for investigating subsidence of original ground surface beneath embankments, the investigations being carried out extensively in connection with railway valuation, as described in the preceding article. The following particulars as to apparatus, methods and costs have been compiled from a number of reports submitted by individual railways to the Railroad Presidents' Conference Committee on federal valuation.

Wash Borings

On the Boston & Maine R.R. and the Boston & Albany R.R. test borings were made by a contractor who had the necessary equipment, which he used in tests on foundation work. The apparatus consisted of a 2-in. pipe casing driven by a drop hammer and having within it a 1-in. jet pipe which could be raised and lowered by a rope and pulley. A force pump with 2-in. suction and 1-in. discharge supplied the jet, water being taken from a tub and returned to it by piping. A pair of tall A-frames of 1½-in. pipe carried a cross-piece with rope and pulley for raising the hammer and the jet pipe and for drawing the casing, which could be driven to a depth of 100 ft. When this casing had been driven to the desired depth, the material within it was washed out by the jet, changes in material being indicated by the appearance of the flow. As a check, the jet pipe was raised and dry samples were taken of the material in the pipe.

Borings were made at intervals of not over 1,000 ft., on alternative sides of the track, being made usually on the shoulders of fills in order to avoid interference with traffic. To establish the bottom of the fill at any station, four borings were made, one in each shoulder, and one in each slope. Valuable information was obtained by bore holes in yards, where the depth of filling material was unknown. To test the accuracy of the records of these borings, pits were dug at adjacent points after sinking 42-in. steel cylinders. These test pits showed that the bottom of the fill as recorded by the borings was within about an inch of the bottom as discovered in the pits. The cost of the apparatus and three men was $20 per day in 1915 and 1916 and the borings averaged 50 ft. per day.

In work on the Central Railroad of New Jersey the boring outfit was set up on the shoulder of the fill and the casing was driven to about the elevation of the original ground surface. After taking a wash sample at this point the driving was continued, samples being taken frequently until the bottom of the filling material was determined. Dry samples were taken in the casing by attaching to the ¾-in. jet pipe a slotted rod used in making soundings, as noted below. The wash borings cost 43c. per lineal foot.

A wash boring outfit used by the valuation department of the New York, New Haven & Hartford R.R., shown in Fig. 1, consists of a pipe tripod carrying a head from which is hung a pulley for operating the drop hammer and pulling up the casing. The hammer is an 8-in. cube with a recess for a 4 x 5-in. cylindrical white oak block with grain vertical. A driving head consisting of a short piece of 2-in. pipe with a steel cap is coupled to the 2-in. casing, which is made in 4½-ft. lengths. Within the casing is driven a ¾-in. jet pipe with lateral outlets and a chisel point. A 1-in. steel rod with pointed end may be fitted to the hammer for driving inside the casing.

For a party of five men, including the engineer, the average cost per week was $106, as shown in the accompanying table. The total cost for equipment, wages and expenses during the entire period, 1915-1918, but exclusive of transportation and 15 per cent overhead, was $15,008, giving an average of 55.4c. per foot of hole bored and 0.20c. per cubic yard of subsidence disclosed.

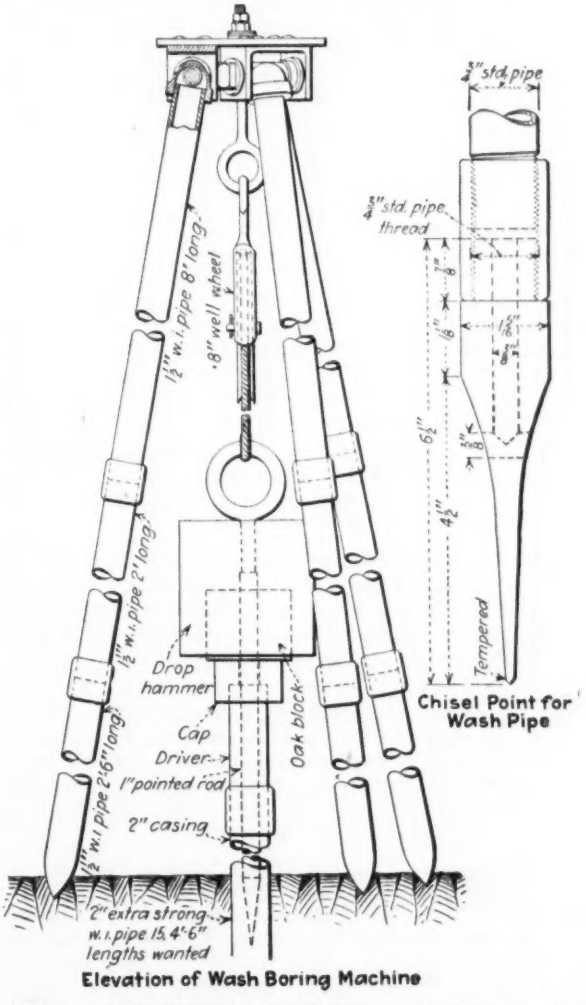


FIG. 1. WASH BORING APPARATUS: N. Y., N. H. & H. R.R.

WEEKLY COST OF TEST BORINGS: N. Y., N. H. & H. R. R.

Men	Wages	Expenses
1 Engineer	$18	$9
1 Foreman	18	6
1 General helper	15	4
1 Helper	14	4
1 Helper	14	4
Total	$79	$27

Core Drills and Augers

A combined drilling and wash boring outfit has been used by the New York Central R.R., the machine having a core drill driven by a 7-hp. gasoline engine and served by a 4 x 5-in. force pump. The drill had a 1¼- and

2¾-in. bit, the casing pipe being 2 and 3½ in., respectively. In loose material the casing was driven and the core washed out, the drill being used when rock was encountered. This outfit had the particular advantage that wash borings could be continued after boulders were encountered. Dry samples can be taken in the casing by means of a special bit or sampler on the end of the rod, but frequent dry sampling increases the cost of the work considerably. This machine can make borings to a depth of several hundred feet.

With a foreman and two helpers the cost of boring (in 1915) was from 70c. to $1.25 per foot under ordinary conditions. On one fill across a swamp the cost of wash borings and core borings was 28c. and $1.30 per foot respectively, exclusive of interest and renewals.

Test borings on the Cleveland, Cincinnati, Chicago & St. Louis Ry. were made with a 2-in. auger having a stem of ¾-in. pipe which could be extended to a length of 40 ft. This auger worked in a casing of 2-in. pipe in 4-ft. lengths. The tools included a maul, two Stilson wrenches and two track jacks for pulling the casing. Pits were made in the toe of the slope and borings were driven from the bottom of the pit until they encountered the natural soil. Augers and post hole diggers have been used by the Chicago, Indianapolis & Louisville R.R. and other roads.

Sounding Rods

Tests of subsurface conditions by sounding with a rod were made on the Boston & Maine R.R. and under favorable conditions the depth of filling material could be determined in this way to a depth of five or six feet. The rod was a 12-ft. length of ½-in. gas pipe with a pointed end and was worked down by one or two men until it reached some resisting material, but it did not appear practicable to make such sounding to a greater depth than 6 ft. in swampy ground. The cost was much less than for wash boring. A solid steel sounding rod used by the New York, New Haven & Hartford R.R. is shown in Fig. 2.

A slotted rod was used by the Central Railroad of New Jersey, with successful results in fills not more than 15 ft. high. The rod was made up of 5-ft. lengths of 1-in. pipe, the lower end of the first section having a ¾-in. slot 8 in. long. After the rod had been churned as far as possible by hand it was driven with a sledge. It was pulled up frequently for taking samples of the material in the slot. To reduce the cost of the investigation, the rod was used at the toes and near the bottom of slopes, wash borings being made on the shoulder at points where the subsidence was deepest. The rod tests cost 7½c. per lineal foot as against 43c. for wash borings, the cost of subsurface material discovered being only 0.11c. per cubic yard.

Dry borings with rods have been made on the Philadelphia & Reading R.R. at a cost of 15c. per foot and 0.02c. per cubic yard of subsurface material disclosed. The boring rod was of ¾-in. pipe in 5-ft. lengths, the first length having a solid end tapering to ⅞-in. diameter in a distance of 6 in. Another length had a slot 6 in. high for cutting and taking samples, leaving a little more than half the section of the pipe. Three Stilson wrenches and 2½ ft. of ¾-in. chain with a ring at one end completed the equipment.

A lining bar was used to start the hole and then the point with one extension piece attached was forced down

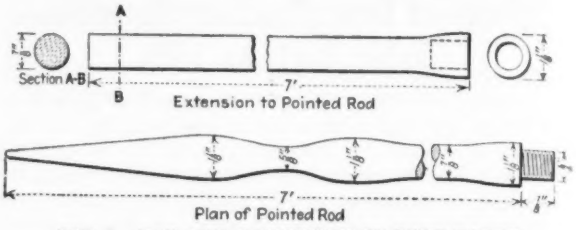


FIG. 2. ROD FOR SOUNDINGS IN SOFT EARTH

by driving or by turning it with the wrenches, three men being required in the latter case. When the point reached a sufficient depth it was withdrawn and the cutter or sampler was inserted, being driven down if necessary. To take a sample the pipe was raised by wrapping the chain around it, the bar being inserted in the ring and used either as a lever or for direct lifting. Three men were all that could work to advantage when forcing down the pipe with wrenches.

Test trenches were cut in the slopes of fills on the Bessemer & Lake Erie R.R. to determine the bottom of the filling material, the trench being made on one side only and extending from the toe nearly to the ends of the ties. Levels were taken over the fill before and after excavating the trench. Tests made in firm ground showed subsidence even where the original surface beyond the toe of the slopes showed no indications of settlement. Pits and trenches at the toes and in the slopes have been used on many roads in exploring for subsurface fill material. Steel cylinders for test pits on the Boston & Maine R.R. have been noted above.

On the New York Central R.R. a party for subsidence tests comprised an assistant engineer in charge, with a foreman and three men from the Carpenter Department, these men being allowed 50c. per day extra for board. Besides a boarding car with sleeping and cooking accommodation there was a flat car for the equipment, the principal items being the drilling tools, handcar, speeder, pipe casings, augers for drilling to a depth of 60 ft. and through timber if necessary, post hole diggers and shovels for digging test pits at toe of slope.

Locations for tests were selected by the valuation engineer, where it was thought that more than 2,000 cu.yd. of subsurface material would be found, the assistant engineer determining where and how often borings should be made at each place. Observations were taken usually at 200-ft. intervals. The observations of this latter party were plotted on sheets of cross-section paper, with their readings marked. The assistant engineer plotted his notes and computed his yardage in the field, making affidavit as to the accuracy of his notes. After the work was completed on a valuation section, the notes and computations for subsurface material on the entire section were bound together, an affidavit was made, and attached to the final report.

Exploration which disclosed 700,000 cu.yd. of subsurface material cost $2,540 (in 1915) including the salary and expenses of the engineer, or an average of 20.5c. per lineal foot of hole and only 0.3c. per cubic yard of material. Beside holes, 367 test pits were dug.

For tests at minor locations and small soft spots a laborer was added to the party, being equipped with a speeder and tools for light drilling. He sounded all the small soft spots. It was considered that the most economical method of exploring small soft spots would be to have an engineer in charge of two men with a rough drilling outfit go over the line on a motor car.

LETTERS TO THE EDITOR

It is the editors' desire to publish here all worth-while letters pertinent to the interests of engineers and contractors. In order that this may be possible contributors are asked to condense their letters to the shortest space consistent with a clear presentation of their ideas.

Elastic Action of Foundation Soil

Sir—Referring to E. G. Haines' communication, p. 89, Jan. 13,1921, I wish to here acknowledge my indebtedness to him for his very original and to me fruitful discussion of J. C. Meem's paper of 1907. I had long observed the lack of correspondence of the actual behavior of earth cuts with that which one would logically deduce from the then prevailing theories of earth pressures; Mr. Haines' discussion set me thinking along what I consider right lines. Since 1907 I have closely observed many miles of earth cuts, tunnels, etc., along the Catskill aqueduct and New York subways, and my observations confirm those of Mr. Haines and Mr. Moulton, both of whom deserve the highest credit. However, my article in Engineering News-Record of Dec. 20, 1920, p. 1268, gave precise data and observations on the properties of earth in foundations, a field other than that covered by Mr. Haines and Mr. Moulton's observations.

Referring to Mr. Meem's letter, p. 185, Jan. 27, the writer has the unpleasant task of the disciple who differs from his old master, for he has learned much from him and leaned long upon him for advice and guidance. Mr. Meem in the fourth paragraph of his letter attributes the rebound to the elasticity of the pile itself rather than to the soil beneath the pile. A little examination of the rebound curves (Fig. 2A, Dec. 20, 1920, p. 1268) will show this to be an untenable assumption, as the pile then would not resettle under reapplications of the same test load. Rebounds of $\frac{3}{4}$ in. have been observed for piles 10 ft. long where the elasticity of the pile itself would account for only $\frac{1}{10}$ inch.

Mr. Meem also states that the inference should not be drawn that the non-maintenance of a percentage of the test load will cause the pile to settle and that the excess test is the real prevention of settlement under the bearing load. I beg to differ; thousands of tests made in the course of our work show this to be erroneous. For example, in tests made for the Bureau of Buildings of Manhattan, New York City, a 14-in. steel pile shell $\frac{3}{4}$ in. thick was sunk 9 ft. in the ground and 2 ft. below water level and filled with 1:2:4 concrete; material at base of pile 95 per cent sand and 5 per cent clay, 95 per cent of the sand passing through No. 100 sieve. Under 50 tons load applied with hydraulic jacks the pile settled about 10 in., upon release of pressure the pile rebounded $\frac{3}{4}$ in., upon reapplication of the load the pile further settled about $1\frac{1}{4}$ in., upon release of the load it again rebounded $\frac{3}{4}$ in., and upon reapplication of the load again settled further about $1\frac{1}{4}$ in. The pile then was retested to 50 tons and wedged with steel beams as per "pretest method"; a rebound of only $\frac{1}{16}$ in. was observed; upon reapplication of the load up to 50 tons a settlement of slightly more than $\frac{1}{16}$ in. occurred, giving a net settlement of $\frac{1}{100}$ inch.

The firm with which I am connected is installing a foundation for an 18-story building at Gold and Frankfort Sts., New York City. Here daily in the course of the work several tests of 20-in. cylinders to 80 tons are made. If anyone doubts the reality of the elastic properties of earth, rebound and the necessity of preventing rebound, and the inadequacy of the excess test alone to prevent settlement, he is welcome to visit this work.

I hope that no one will refuse to look through the telescope to see the moons of Jupiter. When Galileo announced his discovery of the moons a savant denied their reality, as an extended research through the old masters failed to find any mention of them, and upon Galileo's invitation to look at them through his telescope refused. Shortly after, the savant died upon which Galileo remarked that he hoped the soul of the departed upon his ascent to heaven would pass close enough to Jupiter to see his moons.

New York, Feb. 24. LAZARUS WHITE,
Spencer, White & Prentis, Inc., Engineers and Contractors.

Shall the Engineer Arm Be Recognized in Army Promotions?

Sir—The editorial in your issue of March 3, p. 365, upon the need for recognizing the services of Cols. Mason M. Patrick and Edgar Jadwin of the Corps of Engineers, U. S. A., by placing them on the list of permanent brigadier generals soon to be reported to the Senate for confirmation, and by so doing recognizing the engineers of this country for their work in France, has been read with pleasure. I regret that this movement was not undertaken one year ago.

Going to France in August, 1917, and starting my army work by organizing the engineer depots and supply directly under General Patrick, I came to know him about as well as any other officer entering the army from civil life. At that time he was chief engineer, Line of Communications, and all the pioneer work of the tremendous construction program of the A. E. F. was under his charge. Another wonderful piece of work, seemingly forgotten by everybody, was that while doing difficult service as an engineer he was also commanding general, Line of Communications, during the trying winter of 1917. In that capacity he laid the foundation of what was later known as the Services of Supply, and this work, while a side issue in his service, was of inestimable value to the A. E. F.

About May, 1918, he was promoted to be major general and chief of the Air Service and thereafter for a year I knew little of his work except that the Air Service soon seemed to find its feet or, rather, wings. In 1919, as member of the U. S. Liquidation Commission of the War Department, I again came in close touch with him in liquidating the complicated affairs of the Air Service and if my admiration could have been increased it would have been by his work in these matters. In all the conferences on the many matters pertaining to the liquidation of the Air Service never, by word or deed, did he try to "pass the buck" or to explain to the commission that certain matters were the work of his predecessors or in any way attempt to dodge any criticism. I was the only commissioner that knew he was in no way responsible for the early condition of affairs.

Brigadier-General Jadwin carried to a successful completion the largest program of construction work ever undertaken in the world under the direction of one head. I served under him as chief of the Railway and Dock Construction, D. C. and F., and was in daily, almost hourly, contact with him. I have never known a man, in army or civil life, who so well understood the fundamentals of administration, who could so inspire confidence and enthusiasm among those working under him, and who could see and forestall trouble as could General Jadwin.

At the time of the armistice he had 150,000 men working under him at top speed and he never knew the word "impossible" which was dropped, by his example, from the Engineers' vocabulary.

That the service record of these two men should be overlooked in the naming of permanent brigadier generals is unjust and a reflection on the work of American engineers. I propose to urge my friends who served with me in France to bring all the pressure possible to bear so that this injustice may be corrected.

J. H. GRAHAM,
New York, March 7. Formerly Colonel, Corps of Engineers, A. E. F.

Salary of Secretary, Am. Soc. C. E.

At the meeting Jan. 20 of the Board of Direction of the American Society of Civil Engineers the salary of the secretary for the year 1921 was fixed at $10,000.

HINTS FOR THE CONTRACTOR

Save Cost of Bunker by Storing Materials in Surge Chamber

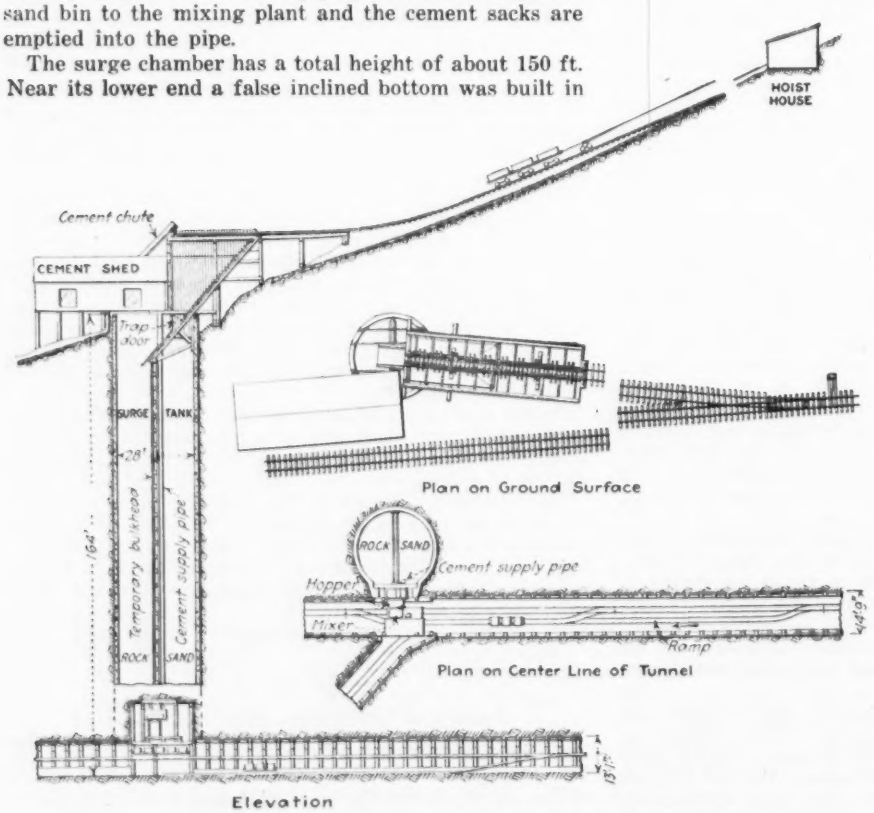
IN PREPARING to place the concrete lining in the tunnel which will serve the penstock of the Caribou hydro-electric development, in California, it was decided that the delay and expense of building a sand-and-gravel bunker could be avoided by using the surge chamber as a temporary storage bin for the materials and locating the mixing plant near its bottom, above tunnel level. The surge chamber is excavated in the hillside above the tunnel and close to its south end where the tunnel meets the construction railroad over which materials are delivered. The general arrangement, as shown in the accompanying drawing, has worked out successfully according to W. D. Shannon, superintendent of construction for Stone & Webster, Inc., the contractor on the project.

Sand and crushed rock are hauled on standard-gage cars up an incline to a switch above the tipple. The cars are then lowered to the tipple and emptied down a very steep chute which has a trap door arrangement by means of which the sand can be discharged into one side of the surge chamber and the rock into the other side, the chamber being divided into halves by a partition built on a diameter.

The cement is hauled up on the same track and chuted into a shed which can store about 2,000 bbl. From this shed a 12-in. steel pipe goes down through the sand bin to the mixing plant and the cement sacks are emptied into the pipe.

The surge chamber has a total height of about 150 ft. Near its lower end a false inclined bottom was built in each side of the partition and trap doors were put in through which the aggregate could be delivered to the mixer below.

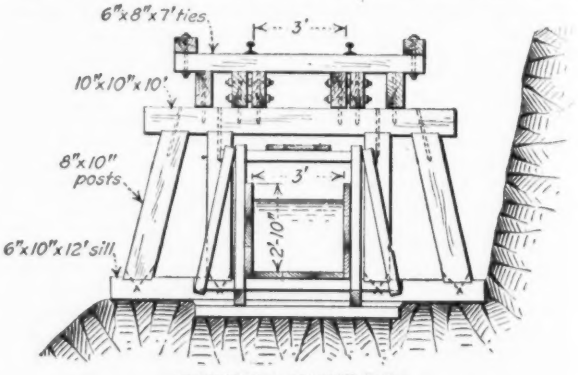
The mixer discharge is above the arch of the tunnel so that materials and concrete are delivered entirely by gravity.



ARRANGEMENT FOR USING SURGE CHAMBER AS BUNKER

Construction Railroad Built Over Flume to Save Excavation

ON THE Caribou project in northern California, a narrow-gage construction railroad was built over a wooden flume at a considerable saving in the cost of construction. The flume, which carries the water for a hydro-electric power house is located in a bench cut and sills for the railroad trestle were slipped under the flume and plumb posts were set just outside the side walls, as shown in the accompanying sketch. This plan provided a roadbed without the expensive excavation that would have been necessary otherwise, and it was made possible for the work to be done in such a way that there was no interference with the usual flow of water in the flume. On the contrary, the water in the flume was used as a means of delivering the timbers which were cut in a sawmill near the head of the flume. An inclined rack in the flume box was so constructed that it could be moved along as the work progressed. It served to stop the timbers at the desired point.



(BOSTON & MAINE R.R.)
SECTION OF TRESTLE AND FLUME

NEWS OF THE WEEK

New York, March 10, 1921

Muscle Shoals Dam Appropriation Is Killed

The fight on the matter of continuing work on the Wilson dam at Muscle Shoals was continued into the closing hours of Congress. The $10,000,000 intended for the continuation of the work during the coming fiscal year finally was eliminated from the Sundry Civil bill when it seemed that the controversy was about to cause the failure of that entire $400,000,000 supply bill.

The question precipitated the most acrimonious controversy of the entire session. There was a small majority in the House against any further appropriation for Muscle Shoals development, but the sentiment in the Senate was well pronounced for continuing the work on the dam. On one hand, the measure was denounced as an effort to loot the Treasury. Those favoring the appropriation declared that the opposition to it had been stirred up by the fertilizer and powder manufacturers. Col. Hugh L. Cooper, testifying before a House committee, declared it would be a national crime to abandon the project after $17,000,000 of the people's money had been expended on the construction of the dam. Closely linked with the dam project is the matter of operating the large nitrate plants.

New Jersey Governor Opposes Port Treaty with New York

A message in opposition to passage this year of the proposed Port Treaty between New York and New Jersey was transmitted to the New Jersey Legislature by Governor Edwards March 1. Governor Edwards said that it would be unwise at this time to commit the state to the treaty until there had been further opportunity of examining and studying the plan recommended by the New York, New Jersey Port and Harbor Development Commission in its report only recently made public.

There has been much criticism of the joint Commission's plan by some New Jersey interests, and a joint resolution at this writing is before the legislative judiciary committee of the New Jersey Assembly for creating a commission to examine into and report before Jan. 1, 1922, on the plan recommended by the bi-state commission.

Sydney Harbor Bridge

Renewed activity in the project to bridge the harbor of Sydney, N. S. W., is indicated by a cable dispatch of Dec. 23, stating that the government of New South Wales plans to invite international bids for such a bridge. Its cost is set at $25,000,000.

Assay of Industrial Waste Is Progressing

A definite scheme of operation for the survey of industrial waste which the council of the Federated American Engineering Societies has undertaken at Herbert Hoover's suggestion went into effect Feb. 7 and on Feb. 21 reports on the first investigation in each industry were made. The work involves examinations in ten key industries as follows: Bituminous coal, building trades, transportation, men's ready-made clothing, printing, paper, metal trades, textiles, shoes and rubber. From three to ten plants of each selected industry are being visited by experienced engineers to secure information desired by the committee. The investigations are being carried on under the following three main subdivisions: Organization, engineering, and production and cost control.

The committee on waste elimination is headed by J. Parke Channing, of New York, chairman, and L. W. Wallace, executive secretary of the council and vice-chairman of the committee. The coal investigation, it is stated, will be completed by April 1.

Danger of Losing Federal Funds in California Denied

A denial that any part of the federal funds apportioned to California for highway improvement is in danger of loss was made recently by the California Highway Commission. The denial is in reply to a published statement issued by the California State Automobile Association that $10,000,000 of such funds allotted to California are in jeopardy.

"The assertion of the Automobile Club is a complete misstatement," says the Highway Commission. "In the first place $10,000,000 has not been apportioned to this state. The total allotment of federal road funds to California is $8,384,000. Of this amount $3,585,000 is covered by project agreements already signed. The commission has until June 30, 1922, to enter into project agreements for the remaining $4,799,000. The commisison is in a position to cover this latter amount three times over.

The only danger to federal funds that has ever confronted California, according to the commission, was the possibility that highway work would have to stop through inability to sell bonds. This danger was overcome by the passage at the last election of amendment 9, making the interest rate on highway bonds flexible and thus assuring their sale.

Power Commission Issues First Licenses

All of Niagara River Cases Disposed of and Ford Permit at Troy Granted

With the completion of its regulations, the Federal Power Commission was able at its session on Feb. 28 to authorize the issuance of its first licenses and permits. Incidentally the meeting was the final one during the term of office of the present commission. As a result every effort was made to take definite action on all pending matters so that the incoming commission would have to deal with a minimum amount of pending questions.

Licenses were issued as follows: The Niagara Falls Power Co., Niagara River; Henry Ford & Son, Inc., Hudson River at Troy, New York; Southern California Edison Co., authorizing an extension of its Big Creek system; Luther Hill, authorizing a project of less than 100 hp. in California.

Preliminary permits were issued as follows: Niagara River Power and Water Supply Co., Niagara River; Hydraulic Race Co., Lockport, N. Y.; Dixie Power Co., White River, Ark.; Washington Irrigation and Development Co., Columbia River, Washington; Pit River Power Co., Pit River, Cal.; United Mills Co., Harpers Creek, N. C. Licenses also were issued for transmission lines as minor parts of some complete projects.

The license authorized for the Niagara Falls Power Co., covers 19,500 cu.ft. per sec. and is to cover a period of fifty years. The company agrees, as a part of the consideration, to amortize completely its investment in Niagara Plants Nos. 1 and 2 and Hydraulic Plant No. 2. The investment in these plants is to be written off completely during the period of the license. Valuation is to be undertaken later. The commission voted unanimuosly that in case of a modification of the existing treaty so as to permit of additional diversion that it is the commission's judgment that it should be handled by the "over the top" development whereby the full head can be obtained by carrying the water to the vicinity of Lewiston.

A preliminary permit was authorized for the Niagara River Power and Water Supply Co., covering 30,000 sec.-ft. in the gorge. The permit is for two years with the understanding that before the license is issued the permittee will submit plans for the utilization of the water under such increased head as is found to be economically practicable. The commisison voted to issue a preliminary permit to the Hydraulic Race Co. covering a diversion of 500 cu.ft. per sec. through the Barge Canal.

The other seven Niagara River applications were rejected. The applications of the Niagara Power & Development Co. and of the Niagara, Lockport and Ontario Power Co. were rejected on the ground that the commission is without authority to issue preliminary permits for the diversion of water from the Niagara River above the falls in excess of the amount authorized by the treaty. No action was taken by the commission which would indicate approval or disapproval if the additional diversion should be arranged. The application of the city of Buffalo was dismissed because no specific plan of development was submitted. The commission also is of the opinion that the city has no legal authority to carry out any scheme of development.

The application of T. Kennard Thomson and Peter A. Porter was rejected because the application comes within the jurisdiction of the International Joint Commission and because of a doubt entertained by the commission as to the feasibility of harnessing the Niagara River below the falls. The application of the Western New York Utility Co. for the diversion of an additional 500 sec. ft. through the Erie Canal was rejected, as was the application of the Niagara Gorge Power Co. The application of Millard F. Bowen for a canal, reservoirs, power houses, conduits and locks between Lake Erie and Lake Ontario also was denied by the commission.

The license authorized for the project of Henry Ford & Son involves the use of the head of water developed by the Troy dam.

Parks Excluded from Provisions of Water-Power Act

In the closing sessions of Congress an amendment to the Federal Water-power Act was approved so as to eliminate from its provivisions existing national parks and monuments. This amendment complies with the promise made last June to the Secretary of the Interior when he agreed to remove his objection to the water-power bill, thereby paving the way for its signature by the President. The amendment was unopposed except by those who wished to strike out the word "existing" and make it apply as well to national parks which may be created in the future. The text of the amendment is as follows:

That hereafter no permit, license, lease, or authorization for dams, conduits, reservoirs, power houses, transmission lines, or other works for storage or carriage of water, or for the development, transmission, or utilization of power, within the limits as now constituted of any national park or national monument shall be granted or made without specific authority of Congress, and so much of the act of Congress approved June 10, 1920, entitled "An act to create a Federal power commission; to provide for the improvement of navigation; the development of water power; the use of the public lands in relation thereto; and to repeal section 18 of the river and harbor appropriation act, approved August 8, 1917, and for other purposes," approved June 10, 1920, as authorizes licensing such uses of existing national parks and national monuments by the Federal power commission is hereby repealed.

Am. Soc. C. E. Amendments Defeated

By a vote of about five to one all of the proposed amendments to the constitution of the American Society of Civil Engineers, sent out some time ago to letter ballot, were defeated. The result was announced by President Webster at the regular meeting of the society held in New York City, March 2. This action clears the way for the committee's new constitution to be presented at the annual convention in Houston, Texas, April 27.

Suggest Steel Superstructure for Belle Isle Bridge

At a public hearing on the Belle Isle bridge project held by the Detroit city council Feb. 24, the possibility of a steel bridge in place of either the cantilever structure designed by the bridge commission or the reinforced-concrete arch bridge for which designs have been submitted by Daniel B. Luten was suggested. Local engineers present at the hearing discussed the several designs and advocated submitting them to a board of engineers. The Detroit Engineering Society submitted a list of sixteen engineers with the recommendation that five be selected to pass upon all bridge designs for the city (see p. 396, March 3 issue).

The effect of foundation conditions on the availability of an arch design was discussed by Prof. L. M. Gram, of Ann Arbor, a member of the commission that prepared the official design (cantilever type). He challenged Mr. Luten or any other engineer to predict the stresses set up by uncertain settlement conditions. Unequal settlement of adjacent piers, he said, would not affect the stresses in the cantilever type of bridge but would be detrimental to a rainforced-concrete arch, and temperature stresses also would present a comparatively serious problem in an arch bridge.

Two Main Questions

Two main questions involved in the present issue are whether the city wishes to spend more money than the amount remaining in the bridge fund, and whether it is possible to build the Luten bridge with the money remaining.

H. H. Esselstyn, of Esselstyn, Murphy & Hanford, supervising engineers of the bridge, stated that he had checked over Mr. Luten's estimates of cost and believed them to be too low, and that the original cantilever proposed could be completed for $3,500,000, estimating the cost on Mr. Luten's unit estimates.

Proponents of a steel bridge suggested among other things that the bridge problem be thrown open for competitive designs, under specifications issued by the city, a competent board to pass upon designs. A steel bridge, it was claimed, would be lighter and cheaper than the official design, and just as substantial and satisfactory from the æsthetic viewpoint.

The majority of the council appears to favor carrying out the original design if possible, although a further bond issue is not considered desirable. Present indications are that the bond issue will be submitted to referendum, and that an affirmative vote will be interpreted as meaning that the original design is wanted by the citizens while a negative vote will mean that the design of the bridge must be such as can be built for the available sum.

Protest High Freight Rates for Wisconsin Road Materials

A protest against what were characterized as excessively high freight rates on crushed stone, gravel, sand and other materials for highway construction and a threat to develop these materials locally at roadside plants, eliminating entirely shipment by rail, were the principal developments of a conference called by the Wisconsin Highway Commission at Madison, Feb. 18, and attended by state and county highway officials, railroad officials, highway contractors, stone, sand and gravel producers, cement producers and dealers, and representatives of surety companies.

The state has available for construction and maintenance of highways in 1921 the sum of $30,000,000. Bonds authorized to be issued for highway construction by the counties of the state aggregate $35,000,000. In the expenditure of these sums both state and counties, according to A R. Hirst, state highway engineer, are forced by the present freight rates to consider the establishment of local quarries and sand and gravel pits in order to bring down the excessive cost of materials. If the state is forced to adopt the policy of producing materials at roadside plants an aggregate investment amounting to many millions of dollars in commercial stone quarries and gravel pits may be wiped out. In order to save the situation, according to Mr. Hirst, an immediate heavy cut must be made in the freight rates prevailing on the highway material.

Quick Action Necessary

"We must know what the railroads find it possible to do," said Mr. Hirst, "not in a few months but as soon as is possible. We are holding the determination of the type of construction of certain of our projects, pending a decision on freight rates. We must act on all these matters soon, because our unemployed demand employment and in one way or the other the work must proceed."

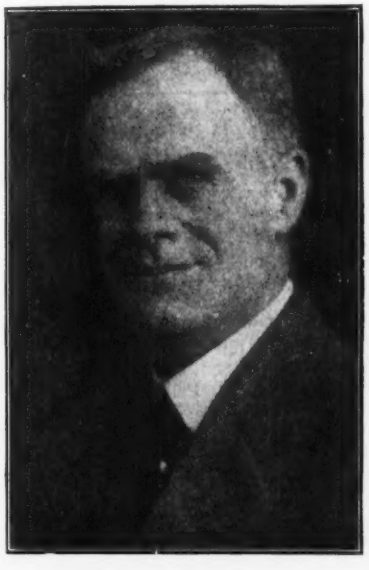
In Wisconsin the increased rate on cement, as compared with 1914 prices, costs more than $1,000 a mile on average location concrete roads. The final stake, according to Mr. Hirst, is whether until millions of tons of materials for the Wisconsin road program are to be commercially produced and moved by rail, or whether these tons are to be largely produced at roadside plants.

The New Administration of the Am. Soc. C. E.

In this issue of "Engineering News-Record" appear the last two of the biographical sketches of the newly elected officers and directors of the American Society of Civil Engineers, as announced in the issue of Jan. 20, p. 140, following the annual meeting.

Frank T. Darrow, Director

Frank T. Darrow, director, District 10 (Lincoln, Neb.), assistant chief engineer of the Chicago, Burlington & Quincy R.R., was born in Corning, Iowa, in 1875, and was graduated with the degree of C. E. from Allegheny College,



FRANK T. DARROW

at Meadville, Pa., in 1897. He began work with the Burlington & Missouri River R.R. (later the C., B. & Q.) in 1897 as back-flagman and was promoted through the various grades on location, maintenance and construction of new lines in Wyoming, Colorado and Montana until in 1902 he became resident engineer on the reconstruction of the Plattsmouth bridge over the Missouri River.

Until 1905 he was engaged on general bridge work for the railroad, when he resigned to become general manager of the International Contract Co. at Seattle, Wash., with C. E. Fowler. He returned to railroad work in October, 1906, as engineer, maintenance-of-way, on the Nebraska district of the C., B. & Q., at Lincoln and was promoted to assistant principal engineer the following year. In 1908 he became engineer of Lines West. He was named assistant chief engineer in 1918 and has continued in that capacity to date.

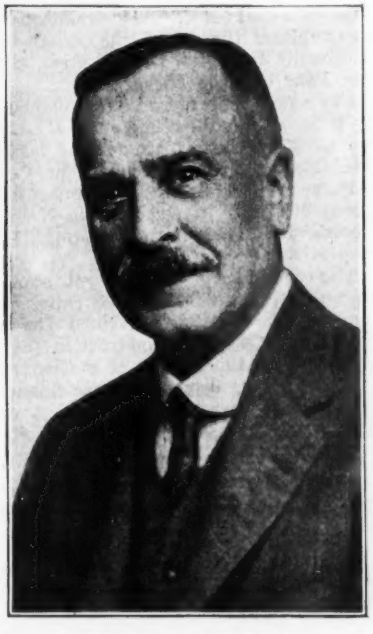
Mr. Darrow received a special appointment in 1914 to devote a year's study of freight houses and freight handling in connection with the Union Station project in Chicago.

George G. Anderson, Director

George G. Anderson, director, District 11 (Los Angeles), is a consulting engineer with wide experience in the field of irrigation. He was born in Aberdeen, Scotland, in 1858 and attended the University of Aberdeen until, in 1874, he became an apprentice with Walker & Beattie, surveyors and engineers, of Aberdeen. After five years of this work he joined the staff of the London & Northwestern Ry. in England, leaving this position after about a year to come to the United States.

In 1880 he was appointed assistant engineer on the construction of the northern Colorado irrigation canal at Denver and three years later became chief engineer of that work and three other Colorado canal systems.

Mr. Anderson entered private practice in 1890 as consulting engineer, specializing in irrigation. Among the works with which he has been connected are the construction of Lake Loveland, one of the first storage reservoirs for irrigation in Colorado; the Imperial Valley project, upon which he reported in 1896; an irrigation project for the Alberta Railroad & Irrigation Co. in Canada; and works for the Canadian Pacific Ry. He built the water-works



GEORGE G. ANDERSON

for Greeley, Col., in 1906, and in association with Leonard Metcalf, consulting engineer of Boston, made an appraisal of the property of the Denver Union Water Co. in 1913 and of the rights of the Spring Valley Water Co. of San Francisco in 1915. He served on the board of consulting engineers for the Imperial Irrigation District with C. E. Grunsky in 1917.

In connection with the controversy over boundary waters between Montana and Alberta Mr. Anderson advised the Canadian Government and in 1919 acted as consulting engineer for Alberta on an irrigation project. He has served as consulting engineer for the city of Colorado Springs on water-works and power development.

Examinations for Engineer Corps

Competitive examinations will be held beginning April 25 to fill vacancies in the various branches of the army. The successful candidates will be appointed second lieutenants. There are 118 vacancies in the Corps of Engineers, which it is hoped will be filled as a result of this examination.

State Engineer Bill Approved

A favorable report has been returned by the Indiana House Ways and Means Committee on House Bill No. 296, which would create the office of state engineer as a division of the department of conservation. The bill is supported by the Conservation Commission.

Changes Recommended for Indiana Highway Commission

Radical changes in the laws governing the administration and operation of the Indiana State Highway Commission are recommended in a report of the state board of accounts, made after an investigation of the affairs of the commission from June 4, 1917, to Sept. 30, 1920. The report was prepared by W. H. Glidewell and A. L. Donaldson, field examiners, and filed Feb. 18 with Jesse H. Eschbach, chief examiner. The main findings and allegations follow:

Thousands of dollars of purchases have been made without proper competitive bids, as is required by law.

The Ohio state highway commission in 1920 expended for "administration, salaries, new equipment, repairs of equipment, transportation, and all other expenses pertaining thereto," 5.7 per cent of the amount it expended for new construction. The Indiana department spent 31.7 per cent.

The average contract price per mile for the 135 miles of roads under construction is given as $35,611, without having figured in cost of engineering, inspection, administration, office equipment, supplies, meals, lodging, auto hire, railroad fare and other overhead which would show actual cost.

The department may receive in the present fiscal year a total of $7,356,725, but it is doubted, according to the report, if the department can build roads fast enough to expend the money.

A bill was introduced in the Indiana Senate, Feb. 19, providing for the repeal of the law under which the present State highway commission operates. It was referred to the Committee on Roads. The bill provides that the funds available for the commission shall go to the State school fund when the commission winds up its business. If the bill should pass, the construction of highways would be placed entirely in the hands of the counties.

Patented Pavements Permissible in Illinois, Court Rules

Under decision just handed down by the Supreme Court of Illinois an act passed in 1919 by the Illinois State Legislature regarding patented pavements is declared constitutional. Prior to that year the use of patented pavements had been prohibited under the Supreme Court's decision of the then existing law. The Legislature then passed an act permitting municipalities to contract for patented pavements provided they are placed in competition with unpatented pavements.

Pursuant to this act the city of Rockford, Ill., received proposals for several types of pavement, including Warrenite-Bitulithic, patented by Warren Bros. Co., Boston. A taxpayer, R. J. Schultz, brought an action to restrain the contract on the grounds that the act of 1919 was unconstitutional and that the proceedings had not fully complied with the act. The Supreme Court, in unanimous opinion written by Mr. Justice Carter, has decided against the plaintiff taxpayer on all points and sustained the decision rendered by the county court more than a year ago. This case has been in the courts for nearly two years.

Bill to Register Builders in New York City

A bill just introduced in both houses of the New York state legislature provides for registering builders in New York City, and prohibits the issuance of building permits to or the conduct of building work by any persons not duly registered. The purpose is to be accomplished by amending the charter of the city by the addition of a registration clause. Under this clause a building permit can be issued only to an architect, engineer, builder, contractor or other person duly registered in the office of the bureau of buildings as a person fully qualified to undertake or supervise the work of construction or alteration covered by the permit.

Concerning the method of registration, the bill provides that the superintendent of buildings shall, within ten days after an application for registration, issue to the applicant a certificate of registration or furnish him a statement in writing setting forth the reasons for rejection.

Certificates of registration may, however, be issued to anyone who has received a permit for building work within the past three years and has not since been convicted of violation of a building regulation. The superintendent of buildings has power to cancel any certificate of registration for cause.

This bill was presented at the instance of the building authorities of New York City. According to Rudolph P. Miller, superintendent of buildings, Borough of Manhattan, its object is to place more definitely the responsibility for proper and safe construction and compliance with the building law. It is supported by a resolution of the Building Officials' Conference, advocating that building operations be restricted to persons of proved ability.

Experience in the borough of Manhattan, Mr. Miller states, has demonstrated the need for a law to fix responsibility on builders. "It has not been unusual for an applicant to submit to this bureau fo approval a set of plans and then to pass on to the builder or owner a different set with the misleading information that they are approved; to work contrary to approved plans; to work without a permit; to make mis statements or misrepresentations in the application or on the plans as to surrounding conditions that vitally affect the validity of the permit; and to change the occupancy of a building after its completion contrary to the certificate of occupancy."

Ask I. C. C. Authority for Union Station at Cleveland

An application for authority and certificate of public convenience for the construction of the proposed high-level union passenger station to be located on the Public Square at Cleveland has been filed with the Interstate Commerce Commission by the New York Central R.R. The application contemplates the use of the passenger station by the New York Central, the Big Four and the Nickel Plate.

For some time it had been planned to build a union station on the Lake front. Then the project for the high-level station was launched. The two plans were described and commented upon editorially in *Engineering News-Record*, Jan. 30, 1919, pp. 241 and 217, respectively.

The granting of the present application will permit the three railroads to contract with the Cleveland Union Terminals Co. for construction and operation of the high-level station so that further legal measures and financing may go forward. The project as now put forward was approved by city ordinance Jan. 6, 1919.

Gear Train Protected in New Type of Water Meter

To prevent damage by acid, alkaline or sand-bearing water the Neptune Meter Co. has developed a Trident meter in which a circulation of water is prevented from reaching the spindles and gears of the gear train, which operates constantly in a bath of lubricant. The flanged disc forming the bottom plate of the gear train fits against the machined surface of the inside of the casing, thus making a tight joint. In assembling, the gear train is filled with a special lubricating compound which reduces friction and protects the metal parts. This new feature is adaptable to all Trident meters up to 1 in. now in service by means of a washer which fits between the shoulders of the disc and forms an equally tight joint in the older types of meters.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Seventh Convention, Buffalo, N. Y., May 9, 10 and 11.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Annual Convention, Houston, Texas, April 27.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York; Spring meeting, Chicago, May 23-26.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; Convention, March 15-17.

The Minnesota Surveyors' and Engineers' Society, at its convention in St. Paul, Feb. 21-23, ratified without a dissenting vote the constitution of the proposed Minnesota Federation of Architectural and Engineering Societies and raised the dues to take care of this additional expense. The proposed registration law for architects and engineers was also indorsed. Sectional meetings devoted to municipal, highway and drainage affairs, were held in the forenoons of the 22nd and 23rd. General assemblies were held in the afternoons. W. N. Ryerson, general manager of the Great Northern Power Co., of Duluth, spoke on the civic responsibilities of the engineer. E. G. Quamme, president of the Federal Land Bank of St. Paul, told of the development of fifty million acres of land in the Great Lakes region and the part the engineer is expected to have in it. At the banquet, Feb. 22, Dean Leland, College of Engineering, of the State University and Horace Lowry, president of the Twin City Rapid Transit Co., were the speakers.

The Providence (R. I.) Section, Am. Soc. C. E. and the **Providence Engineering Society** held a joint meeting Feb. 15 at which Arthur P. Davis delivered an illustrated lecture on "National Irrigation." Mr. Davis described for the first time in public the project for flood control of the Colorado River.

The New Jersey Sewage Works Association, at its meeting, Feb. 18, elected the following officers: President, C. G. Wigley of Maplewood; vice-presidents, S. F. Miller of South Orange and M. C. Smith of Newton; secretary-treasurer, M. E. Fuller of Summit.

The Engineering Society of Wisconsin, at its annual meeting in Madison Feb. 21-23, elected the following officers: President, Prof. C. I. Corp; vice-president, Jerry Donohue. Resolutions were passed advocating that the state legislature compel the licensing of all engineers, the establishment of a college of architecture at the state university, and the deepening of the St.

Lawrence River for the use of ocean liners.

The Portland Section, Am. Soc. C. E., at a recent meeting, passed a resolution calling upon the board of direction of the society to restore the policy of publishing technical papers and discussions in full in the *Proceedings*. The present publication policy is condemned. The point is made that the principal benefit of membership in the society and for which dues are paid is the receipt of technical papers and discussions thereon. Copies of the resolution have been forwarded to all of the other sections of the society with the request that each express to the board of direction its views regarding future publications.

PERSONAL NOTES

C. T. JACKSON, district engineer Chicago, Milwaukee & St. Paul Ry., has been appointed principal assistant engineer with office at Chicago.

JAMES, PROCTOR & REDFERN, LTD., is the new name of the E. A. James Co., Ltd., Toronto, Ont. Mr. Proctor has been with the company as managing director since 1916 and continues his work as vice-president and managing director. Mr. Redfern during the past year has acted as secretary-treasurer for the company and will continue in that office. The business will continue as an organization of consulting municipal engineers.

A. N. WARDLE, member of the engineering party sent to Athens, Greece, last summer by Ford, Bacon & Davis on the design of system of water supply and sewerage of Athens and Peiraeus has returned and become associated with the Holway Engineering Co., civil and sanitary engineer, Tulsa, Okla. Mr. Wardle was formerly chief engineer West Virginia State Board of Health.

C. R. THOMAS, in charge of the publication of results, Forest Products Laboratory, Madison, Wis., has resigned to become editor of the *Professional Engineer*, the magazine of the American Association of Engineers. Mr. Thomas was formerly associate editor of *Engineering & Contracting* and more recently editor of *Successful Methods*.

EDMUND T. PERKINS, Edmund T. Perkins Engineering Co., consulting engineer, Chicago, will sail for Barranquilla, Colombia, South America, March 15. He is to report upon an extension of the activities of the El Prado Co., a Colombian engineering and construction corporation which is a consolidation of (1) an old Colombian construction company, de la Rosa Hermanos, (2) the engineering organization of K. C. Parrish, operating in the country for 16 years and (3) Middle West capitalists. Daniel C. Breck, Selden-Breck Construction, Co., St. Louis, is now on the ground for the same purpose with an engineer and architect.

BYRON W. BENEDICT has resigned as city engineer of Lockport, N. Y., to become manager of the securities department of the American Gas Co., Philadelphia.

F. C. DUGAN, formerly designing engineer, sewerage divison, office of city engineer, Flint, Mich., has been appointed state sanitary engineer of Kentucky, with headquarters in Louisville.

E. Y. ALLEN, valuation engineer of the Central R.R. of N. J., and the Philadelphia & Reading Ry., will, from March 1, devote his entire time to the department of valuation of the Reading System.

W. W. JAMES, formerly assistant valuation engineer, Central R.R. of N. J., has been appointed valuation engineer to succeed E. Y. Allen. Mr. James has been connected with the company for about 18 years.

BESSELIEVRE, DISHER & MILLER, INC., engineers and constructors, have opened offices in New York City. E. B. Besselievre is a consulting engineer with 14 years' experience and specialization in the design and construction of sewerage systems, sewage treatment plants and general sanitary engineering practice for municipalities, industrial plants, etc. He is at present acting as advisory engineer for the Chemical Warfare Service, U. S. A., Lakehurst, N. J. Q. F. Disher has supervised, as chief field engineer, construction of many sewerage and water systems, sewage and water treatment plants, roads, and general utilities for municipalities in many states. C. W. Miller is experienced in the design and construction of general utilities, power plants, gas plants, and general engineering layouts.

D. G. FISHBECK, formerly with the engineering department of the Turner Construction Co., New York, has accepted a position on the faculty of West Virginia University in the department of mechanics.

G. D. HASTINGS, formerly city assessor and acting manager, has been appointed town manager of Guelph, Ont.

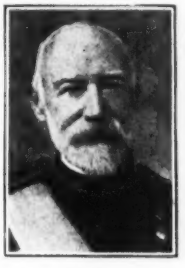
C. C. CUNNINGHAM has been appointed division engineer of the Kansas division Chicago, Rock Island & Pacific Ry., with headquarters at Herington, Kan.

W. W. SCHLECHT, project manager U. S. Reclamation Service, Yuma Project, Yuma, Ariz., has resigned. He has been with the Reclamation Service almost continuously since its establishment.

GEORGE F. DREW has resigned as chief engineer of the Pejepscot Paper Co., Brunswick, Me., and contemplates taking up the practice of general mill engineering with office at Brunswick.

OBITUARY

MAJOR-GEN. ALEXANDER MACKENZIE, U. S. A., retired, and former Chief of Engineers, died Feb. 23 in Washington, D. C. He was born in Potosi, Wis., in 1844 and was graduated from the U. S. Military Academy, West Point, in 1864, when his service with the Corps of Engineers, U. S. Army, began. After serving in the Civil War with rank of captain he engaged in important public works construction, including the improvement of the harbors of Lake Michigan, the construction of the Louisville and the Portland canals. From 1895 to 1903 he was first assistant to the Chief of Engineers, a member of the Missouri River Commission and member of the Lighthouse Board. He was promoted to colonel in 1901. On Jan. 23, 1904, he was made brigadier-general and Chief of Engineers. He was retired after fourty-four years of active service, May 25, 1908, but continued his interest in engineering matters. During the World War he again entered the service and continued on active duty until about a year ago.



COL. MICHAEL J. MCDONOUGH, Corps of Engineers, U. S. Army, died Feb. 13 in Denver, Col. He was born in Boston, Mass., in 1877 and was graduated from the U. S. Military Academy in 1899. He began his army service with the Artillery, later being transferred to the Engineers. From 1900 to 1902, he was stationed at Ft. Barrancas, Pensacola, Fla., on electrical installations, concrete work in seacoast batteries, building construction, harbor construction, dredging, and installation and development of a system of fire control for seacoast guns. He left this work to enter the Engineer School of Application, Washington Barracks, Washington, D. C. In 1903 he became assistant instructor in practical military engineering at the U. S. Military Academy (under Major M. M. Patrick). During this time he assisted Major Patrick in constructing a pipe line from Ft. Montgomery to West Point, and in similar projects. He was instructor of cadets in topographical surveying and in military road reconnaissance. Colonel McDonough is joint author with Col. P. S. Bond of the widely known book "The Technique of Modern Tactics." In 1917, when about to leave with his regiment for duty in France, he developed tuberculosis and was placed in the U. S. Army general hospital. He has spent about three years in the West. Col. McDonough was graduated as number 15 in his class at West Point.

Civil Engineers Fail To Elect Secretary

In accordance with a decision made at the meeting of the board of direction of the American Society of Civil Engineers in January the election of a secretary of the society was one of the principal items of business at the board meeting, March 7. A committee of past-presidents, in accordance with previous instructions, reported on the qualifications of the candidates. Balloting was then ordered by the board, said balloting to continue until a choice is made, the result to be announced at the Houston convention.

Chicago Railway Terminal Commission Changes

John F. Wallace and Bion J. Arnold, consulting engineers, have resigned from the Chicago municipal commission on railway terminals. Mr. Wallace is succeeded as chairman by W. F. Lipps, who was formerly chairman of the city council committee on railway terminals. Edward J. Noonan, chief engineer for the commission, succeeds Mr. Arnold.

Clinton, Iowa, Rejects Municipal Ownership of Water-Works

By a vote of 3,201 to 722, Feb. 11, Clinton, Ia., rejected a proposal to acquire the privately-owned waterworks now supplying the city. A proposal for a $435,000 bond issue to supplement an existing debt of $465,000 against the property was also voted down 3,252 to 724.

Six-Year Comparison of Wholesale Commodity Prices and Building Materials Costs

Aberthaw Construction Company's Analysis Shows Latter Are Now Approaching Commodity Level

By H. E. Keyes
Aberthaw Construction Company, Boston

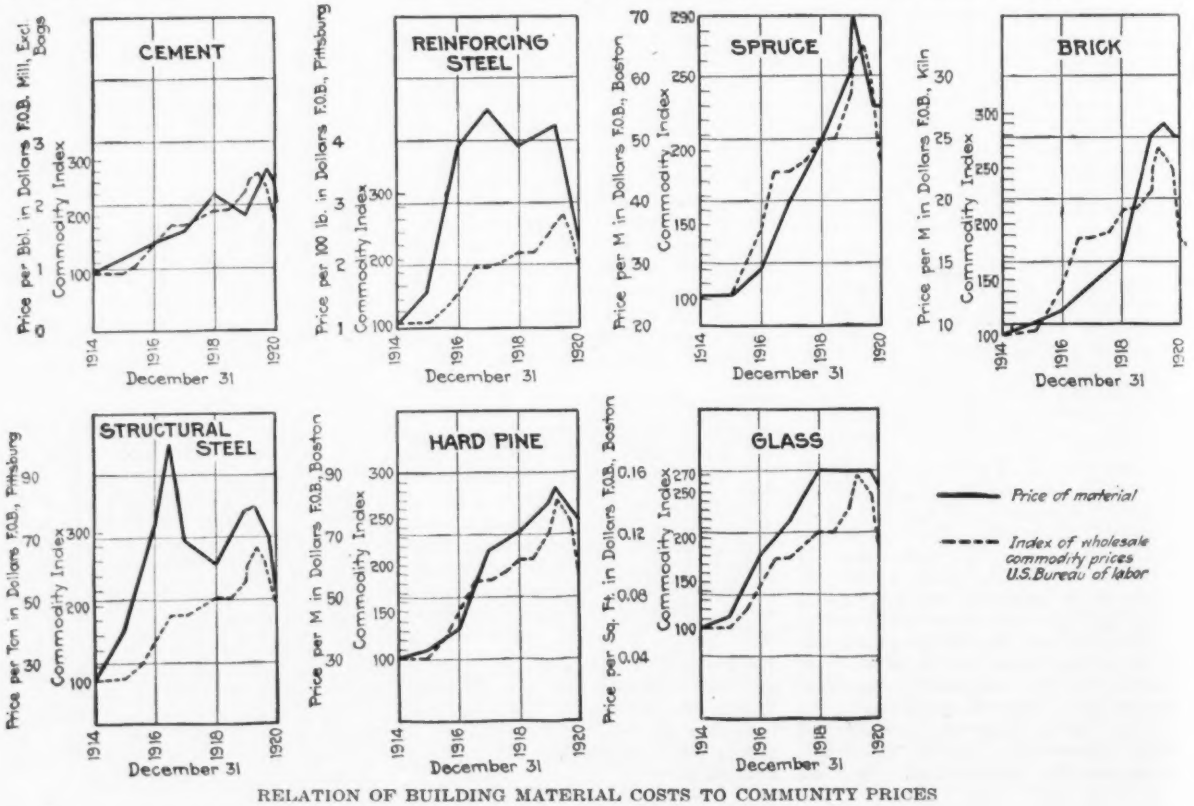
The close of 1920 put an end to skyrocketing of building material prices and saw the majority of those prices moving tamely but swiftly toward the level of commodities in general. This is clearly shown in the accompanying set of charts prepared by P. F. Ayer, planning department, Aberthaw Construction Co., in which the relation between the prices of building materials and of wholesale commodities is compactly presented for the period from 1914 to 1920.

The commodity index scale starts at 100 in 1914 at the level of a particular commodity price at that time. The figure 200 on the commodity index scale is at the same level as twice the 1914 price, so that the price curve of the particular material under consideration can be read either on the price scale, showing actual material prices, or on the commodity index scale, showing the relative price of the material to the basic 1914 price.

The commodity price index used is that of the United States Bureau of Labor Statistics. The scale of building material prices is the scale of actual cost of the materials—not their quoted prices. This is particularly important in the case of steel, which, throughout the war and for some time subsequent thereto, exhibited a wide disparity between quotations and delivery prices.

The chart offers a text for a variety of discussions. Perhaps its most obvious indication, however, is that of the extraordinary sensitiveness of steel prices to actual conditions of demand and supply. The great sinews of modern war are of steel. Hence, steel, even though weighted by government control, was the first structural material to make a conspicuous rise from the general commodity level. With the special demand withdrawn, steel has made the swiftest approach to the level of other things.

It is to be observed that the charted line extends only to the close of 1920. The first few weeks of 1921 have witnessed still further declines both in the commodity index and in the quoted prices for building materials. The commodity index has declined to 177 since Jan. 1, 1921. Actual prices of building materials—that is, prices for cash purchases in quantity—are only formally quotable, since there is no market worthy of the name and hence no real knowledge of the purchasing power of a dollar that has the courage to venture out in actual quest of goods.


CEMENT
Price per Bbl. in Dollars F.O.B. Mill, Excl. Bags
Commodity Index
December 31
REINFORCING STEEL
Price per 100 lb. in Dollars F.O.B., Pittsburg
SPRUCE
Price per M in Dollars F.O.B., Boston
BRICK
Price per M in Dollars F.O.B., Kiln
STRUCTURAL STEEL
Price per Ton in Dollars F.O.B., Pittsburg
HARD PINE
Price per M in Dollars F.O.B., Boston
GLASS
Price per Sq. Ft. in Dollars F.O.B., Boston
Price of material
Index of wholesale commodity prices U.S. Bureau of labor

RELATION OF BUILDING MATERIAL COSTS TO COMMUNITY PRICES

Construction Conference Urges Price Deflation

Lower Re-discount Rates and Governmental Economies Essential—Local Conferences Urged

Frankly stating that public distrust of the construction industries is the cause of the present stagnation in building, the National Construction Conference at Chicago on March 2 and 3 advised "drastic deflation of prices and wages to an irreducible minimum." While each charged responsibility for inaction to the others, labor, management, capital and transportation all agreed on this main fact. Organized labor, it is to be particularly noted, was as prompt in accepting its duty in readjustment as were capital and management. With the decision that deflation is necessary the conference recommended that local conferences be held to state the problem and arrive at means for concerted action and that individual industries review and revise their prices to secure complete deflation at the earliest possible moment.

Cheaper Money Essential

Striking the keynote of the conference with the statement that no remedy was possible unless all interests approached the situation with a determination to sacrifice something Harry A. Wheeler, vice-president, Union Trust Co., Chicago, announced that "it is obvious that cheaper money is essential to the start of building operations." If it may be expected that labor, materials, transportation and money will recede no further then this is the time to begin to build, and to convince the public that such is the case. If, on the other hand, we may expect that these commodities will be cheaper, every effort must now be made to arrive at that stage of an "irreducible price level" when reconstruction may start.

Rediscount rates, expressing the financial remedy to the building trade Mr. Wheeler said, are the main obstacles facing the construction business. "If re-discount rates were lowered today current money rates would fall within 48 hours," he said. "From our viewpoint," he continued, "that is the biggest item now obstructing the financing of building projects. If the Federal Reserve system will lower its re-discount rate in conformity with the rate now prevalent in a number of commodities the banks will immediately lower their interest rates on money."

Railways Cannot Reduce Rates

C. H. Markham, president of the Illinois Central R.R., spoke on the transportation problem as it affects the construction industry, urging builders to co-operate with the railroads in furthering liquidation. He was supported by A. J. County, vice-president, Pennsylvania R.R., who stated that there will be no increases in rates despite the frequent deficits, but on the other hand there can be no decrease for some time to come. Mr. County stated that the "railroads have made a serious deflation in their outlays and costs, and are looking to the other trades and industries to help in making a basis on which business can resume." High costs and profits must be deflated to meet present conditions, he said. Industries can get close to their customers with prices for raw materials and finished work that will influence them to enter the market. We must also look for the government to assist this deflation program by definite steps: (1) The fixing of war indemnities and the funding of the war debts and costs of the various nations, as well as our own, so that the same may be spread over a fifty-year period; (2) reduction to a peace basis of governmental staffs and bureaus—federal, state and municipal—to bring about a reduction in heavy taxes."

The government, he asserted, must join in a program of cutting off large expenditures for non-productive work, and those that will not reduce expenses, and finish only those projects so far advanced that it will mean a waste of capital to stop the work.

High Prices Control—Not High Wages

Speaking for organized labor James Bulger, president of the Denver Trades Division of the National Federation, said: "Everyone who has taken part in this conference has taken a keen pleasure in 'passing the buck.' The railways have laid the trouble to labor and rates. The banks, as represented here, mention re-discount rates as the trouble, and labor. Coal representatives who have spoken at this conference have stated that 80 per cent of the cost of coal is due to labor. Construction men have plainly intimated that housing operations would start just as soon as labor reduces its wages. Labor may be somewhat at fault. That may be said of a number of things pertinent to the construction industry. But deeper than that it is indisputable that the real obstacle in the way of commencing building operation and one of the principal causes of unemployment are the high prices of building materials."

Conclusions

Summarized briefly the conference disclosed that current costs of construction materials still remain much and erratically higher as compared with pre-war costs and compared with the average of all other commodities. Current construction labor costs have not had proper adjustment to accord with present conditions. Practices and conditions surrounding financing of building construction require modification. Relations between employers and employees call for improvement and stabilization to secure continuity of operations in all building construction, and employers and contractors have not progressed to the needed extent in effecting reasonably prompt deflation of values throughout the construction industry (and all stages thereof from raw materials to finished products), including their own overhead and profit.

The conference was held under the direction of the National Federation of Construction Industries, Ernest T. Trigg, Philadelphia, Pa., president.

Chicago Expert Builders Formed

Chicago Expert Builders, an association of all classes of industry and science engaged in or connected with the construction industry, was formed last week. The application for a charter sets forth the objects of the association as follows: (1) To build Chicago better; (2) to further and promote high ideals in civic development and to encourage efficiency and public faith in municipal works; (3) to make available to the community the highest type of expert advice in construction and engineering problems; and (4) to make possible full co-operation between all classes of interests engaged in construction.

In personnel, the charter membership list contains names of engineers, architects and contractors, representatives of material producers, bonding companies, real estate operators and legal advisers. With no definite program established, it is felt that free intercourse between these various interlocking interests will result in the formulation of a program productive of benefit to the entire community. Following are the officers of the new association: William M. Lawton, attorney for the Real Estate Association of Illinois, president; Robert Isham Randolph, consulting engineer, first vice-president; Frank D. Chase, of Frank D. Chase, Inc., second vice-president; Ivan O. Ackley, real estate operator, secretary; and Hiram S. Cody, Chicago Trust Co., treasurer. Others among the incorporators are Wensel Morava, steel contractor, Harry B. Wheelock, architect, Peter Aagaard, contractor, Justin G. McCarthy, paint manufacturer and F. H. Rudderham, lumber dealer.

Building Report of Manhattan for February

According to the report of the superintendent of buildings, Borough of Manhattan, New York City, plans were filed during February for the construction of thirty-three new buildings costing a total of $8,861,360. Plans were filed for one tenement house, costing $250,000; one hotel, $1,500,000; six stores and loft buildings, $1,316,250; five office buildings, $3,355,000; one factory, $75,000; one church, $75,000; one municipal building, $79,000· one place of amusement, $1,500,000; nine garages, $505,600; and seven other structures, $5,610. Applications were made to alter 221 buildings at a total cost of $1,582,615.

Pennsylvania and Illinois Reject Road Bids

Nineteen of the twenty-six road construction projects on which the Pennsylvania highway department received bids Feb. 19 were rejected. All of the bids received Feb. 18 by the highway department of Illinois were rejected, the cause being the same in each case—excessive prices. In the case of Pennsylvania the low bids averaged in excess of $70,000 per mile, while in Illinois the average was about $50,000.

In rejecting the Pennsylvania bids State Highway Commissioner Sadler said that he did not believe prices submitted were representative of the downward trend of prices in labor and materials. The projects will soon be readvertised.

Call for Bids on Hudson Vehicle Tunnel Shafts

The second call for bids on construction connected with the Hudson River vehicular tunnel has been set for March 29. The work involved is the construction and sinking of two ventilating shafts to be located in the Erie R.R. yards at the Jersey end of the tubes. Due to more favorable ground conditions than existed on the Manhattan side, where steel caissons were called for, reinforced-concrete caissons have been selected as the type for the Jersey shafts.

Conditions in the Common Brick Industry

According to the March digest of the Common Brick Manufacturers Association of America, 98 out of 142 concerns reporting have made no recent reduction in the price of brick. Seven concerns have cut the price $3 a thousand; twenty, $2 a thousand; sixteen reduced less than $2 a thousand, and one concern reported a cut more than $3 a thousand. The 142 concerns represent approximately 40 per cent of the country's total production. After from three to six months of almost complete inactivity in the brick industry, prices range from $13 to $25 per thousand at the plants, with only four concerns out of the 142 quoting the lower figure.

More brick was shipped than during the preceding month, stocks on hand being reduced to 352,000,000 brick. The ratio of orders also has decreased, being 34 per cent as compared with the preceding report of 50½ per cent. Eighty-one per cent of the plants reporting are closed as compared with 86 per cent the month preceding. There is less than one month's normal supply of brick in the yards. Nearly all manufacturers who have resumed production, report labor supply and efficiency favorable and coal supply ample.

There is only one section of the country — Southern California — which is over-sold on common brick. The burnt brick on hand in that section, including California, Arizona and Nevada is approximately 15,000,000, whereas the orders on books total approximately 16,500,000 brick.

Manufacturers declare a further recession in prices depends on a downward revision in freight rates.

Lumber Orders and Shipments Greater Than Cut

For the first eight weeks of 1921 orders received from the seven associations of the National Lumber Manufacturers Association were 8 per cent in excess of the cut for the same period. The total shipments, though not so large as the orders received, exceeded the production by 5 per cent. The total production for the 8 weeks was 945,106,500 ft. b.m.; the shipments 993,624,038 ft. b.m.; and the orders 1,016,236,358 ft. b.m. These figures represent approximately 50 per cent of normal production, orders, and shipments.

January Imports and Exports Show Decline

According to a report recently issued by the Department of Commerce there was a sharp falling off in American trade with Europe and South America in January as compared with December. Our exports to Europe in January were $325,530,000 as compared with $388,587,000 in December, and the total export trade amounted to $674,740,000 in January as compared to $720,852,000 in December. Imports totaled $208,814,000 in January as compared with $266,112,000 in December, 1920.

Oil Pipe Line Abandoned

The oil pipe line from Le Havre to Paris, which was to have been constructed by a co-operative arrangement between French and American interests, as noted in *Engineering News-Record* of Sept. 16, 1920, p. 555, has been abandoned. Original plans provided for the engineering work to be done by the American Oil Engineering Co. and the construction under the general supervision of James Stewart & Co.

Wage Reduction in Shipyards Due on April 1

According to an announcement made March 7 by an attorney representing a group of shipbuilding companies wages in most of the plants located in Brooklyn and Staten Island, N. Y., and in Hoboken, N. J., are to be reduced 10 per cent beginning April 1. It is said that approximately 30,000 employees will be affected.

Panama Lock Gate Claim Settled

Settlement of the long-standing claim of the McClintic-Marshall Construction Co., Pittsburgh, for losses due to extra work required in building the steel lock gates for the Panama Canal, was accomplished by an appropriation of $714,007.39 by Congress in the session just closed. The company's original claim for extra work exceeded $2,000,000, but a commission appointed to investigate the expenditures reported five years ago that the company was entitled to the sum which Congress has now appropriated.

Wages Cut in Building Trades

During the past few weeks building trades employers in several cities have announced wage reductions. According to press reports the mason contractors of Detroit have reduced bricklayers wages 20 per cent, the new scale being $1 per hour. The master plumbers association of Fairfield County, Conn., cut plumbers' wages March 1 from $10 to $7 per day, at the same time reducing master plumbers' pay. Voluntary reductions have been accepted by the Boise, Idaho, building trades workers, as a result of a conference between contractors and workers in which plans for a stimulation of construction work were laid.

As a result of its refusal to accept a wage reduction of 12½ per cent the building trades council of Portland, Ore., has been informed by the employers that the wage agreement existing between the two associations will terminate May 1.

Several important industrial concerns have recently announced wage reductions, among them being the Truscon Steel Co., and the General Fireproofing Co., Youngstown, Ohio; the Baltimore Drydocks and Shipbuilding Co.; and several independent steel manufacturers, including the Jones and Laughlin Steel Co., Pittsburgh.

Miscellaneous Building Leads in Active Week

Despite the rejection of bids for state highway work in both Illinois and Pennsylvania during the past week, highway contracts have been let that represent a total outlay of about $2,000,000. Miscellaneous building, such as educational, office and bank, amusement, loft, apartment, continues active, thirty-eight contracts having been let which calls for a total expenditure of $11,741,121. In that figure are included four apartment houses in New York City to cost, together, close to $1,000,000.

The highway commission of Ohio let contracts for 32 miles of highways, mostly concrete or reinforced concrete, the total of the contracts being $965,709. Other smaller road and pavement contracts let brings the total for the week to approximately $2,000,000. Ohio is to receive bids March 18 for highway construction projects on which the engineers total estimate exceeds $1,500,000.

Considerable public works construction is being undertaken, the largest contracts let during the past week being Detroit municipal sewer contracts awarded on four sections for a total cost of $722,458.

The number of proposals noted in this week's construction news section indicates that miscellaneous building promises a healthy increase during the coming months.

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